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THESIS

SINGLE OPERATOR CONTROL OF MULTIPLE UNINHABITED AIR VEHICLES: SITUATIONAL AWARENESS REQUIREMENT

by

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September 2008

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13. ABSTRACT (maximum 200 words)

Militaries around the world, as well as other government agencies, are increasingly using uninhabited vehicles to perform dull, dirty and dangerous work. In the United States, laws currently mandate their increasing use throughout the armed services, with set percentages of overall vehicle fleets. Currently, teams of people operate these vehicles, especially Uninhabited Air vehicles (UAVs). For example, n:1, where n is the number of operators and n > 1. The ultimate goal, and the object of much research, is the technology to lower, or even invert the control ratio from many people to one vehicle to one operator of several vehicles, e.g., 1:m, where m is the number of vehicles and m ≥ 1. While the technology to automate these vehicles continues to progress at a rapid pace, less attention has been paid to the Human Factors aspect. Theoretically, technology exists to enable single operator control of multiple UAVs; however, the human operator must interact with the vehicle, especially if the vehicle will be used to apply deadly force. What information does the operator readily need to make these critical decisions? How will the human operators be able maintain the situational awareness of all vehicles under their control and make informed decisions as to their employment in dynamic situations? One possible aid to maintaining Situational Awareness is an overall Situational Awareness display that gives an overview of the vehicle locations, both geographically and in relation to one another. The question to be answered is whether this display adds useful information to the operator without further straining the operator's limited attention resources.

Experiment participants were tasked to provide supervisory control of four simulated UAVs in a simulated environment and make tasking decisions for the UAVs based on static ground targets that required investigation. Accuracy of situational awareness information was measured with and without the additional Situation Awareness display to determine the net benefit of adding an additional display to the operator's station. Results indicate that the Situational Awareness diplsay helped the UAV pilot make more accurate decisions regarding the UAV in closest proximity to a target requiring re-investigation. Contrary to expectations, the SA display did not increase the speed of decision making for re-assigning the UAVs to a target of interest. The results support the conclusion that operators of multiple UAVs should have some form of Situational Awareness display to aid in determining the UAVS location geopgraphically and in relation to other UAVs and search objects.

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SINGLE OPERATOR CONTROL OF MULTIPLE UNINHABITED AIR VEHICLES: SITUATIONAL AWARENESS REQUIREMENT

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TABLE OF CONTENTS

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LIST OF FIGURES

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LIST OF TABLES

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I. INTRODUCTION

A. UNINHABITED AIR VEHICLES

A number of NATO countries, including the United States and Canada use Uninhabited Military Vehicles (UMVs) to augment their manned forces, especially in performing tasks, which are dull, dirty, or dangerous. One of the force augmentation issues relevant to the human operator is UMV control station design. These human interface issues include guaranteeing appropriate situational awareness for the task, minimizing adverse effects of system time delays, establishing an optimum ratio of operators to vehicles, and providing effective information presentation and control strategies. Finally, for UMVs to be successful, they must be successfully integrated with manned systems to enhance the strength of the overall force. Human factors considerations in this area include how manned systems should best collaborate with UMVs, deconfliction concerns, and command and control issues (Task Group HFM-078/TG-017, 2007). Uninhabited air vehicles (UAVs) are of particular interest to the defence sector because they have the potential to significantly reduce the risk to aircrew in military operations (Baxter & Horn, 2005) as well as the weight and cost of aircraft.

In the United States, the push for more Uninhabited Air Vehicles (UAVs) is codified in Public Law 106-398, the National Defense Authorization Act for Fiscal Year 2001. Section 220 states that “It shall be a goal of the Armed Forces to achieve the fielding of unmanned, remotely controlled technology such that… by 2010, one-third of the aircraft in the operational deep strike aircraft fleet are unmanned (Spence, October 30, 2000).” In Appendix 114 to the law, it further states that the department of the Army should work with the “Defense Advanced Research Projects Agency for demonstration and development of the Future Combat System to reflect an increase in unmanned, remotely controlled enabling technologies” (Spence, October 30, 2000). The act further demands a “plan to

implement a program that examines the ongoing Air Force unmanned combat air vehicle program and identifies an approach to develop a Navy unmanned combat air vehicle program that has the goal of developing an aircraft that is suitable for aircraft carrier use and has maximum commonality with the aircraft under the Air Force program" (Spence, October 30, 2000).

In Canada, direction for the requirement for UAV in the Canadian Forces flows from several sources. The Government of Canada's International Policy statement (2005) provides the policy and intellectual framework for the transformation of the Canadian Forces into a more relevant, responsive, and effective military force. A UAV capability is an important part of this transformation in the Canadian Forces (UAV JPO, 2006). The way ahead for UAVs within the Canadian Forces is outlined in the Canadian Forces (CF) UAV Campaign Plan. The CF will "acquire by 2010, through a series of related projects guided by a common investment strategy, a 'family of UAVs' that will enhance the CF operational effectiveness and contribute to the situational awareness of Commanders at all levels" (UAV JPO, 2006). Although the governing documents do not specify the numbers of UAVs or operating cincepts, they do specify that UAVs will be a critical capability for Intelligence, Surveillance Targetting and Reconnaissance (ISTAR). Ongoing programs exist within the Canadian Forces to upgrade and enhance the tactical UAV capability currently fielded in support of Canadian troops in Afghanistan.

DARPA conducts the Urban Challenge program in support of this Congressional mandate. In their words, "every "dull, dirty, or dangerous" task that can be carried out using a machine instead of a human protects our warfighters and allows valuable human resources to be used more effectively (DARPA, 2008).

Several U.S. government documents mandate or refer to the desire to achieve single operator control of multiple UMVs. The Office of the Secretary of Defense (OSD) Uninhabited Aerial System Roadmap has several references to

its desire to achieve a state where a single operator is able to effectively operate more than one vehicle to gain advantages in logistics requirements:

> Advancing the state of the art in all of the areas discussed [in the report] allow a single person to control multiple aircraft. Highly autonomous aircraft have reduced requirements for ground equipment and communications and can leverage advances in displays and voice control. The benefits of this are reduced manpower, reduced hardware (and therefore logistics), and increased effectiveness (Cambone, Pace, Krieg, & Wells, 2005).

The UAS roadmap goes on to express the desire for one operator to control multiple UAVs within Federal Aviation Administration (FAA) controlled airspace: "Work with the FAA to define appropriate conditions and requirements under which a single pilot would be allowed to control multiple airborne UA simultaneously" (Cambone et al., 2005) and enable seamless integration into existing command and control architectures. "JRP [Joint Robotics Program] developers have made inroads into addressing these future needs by exploring technologies necessary to allow seamless command and control architectures capable of controlling multiple unmanned systems in all operating environments" (Cambone et al., 2005).

NATO documents also state the need for single operator control of multiple UAVS. "Currently, it is a priority in many NATO Nations UAV research programmes to reduce the manpower burden by reducing the ratio of operators to vehicles for flight and mission control. A common aim is to increase operator effectiveness by enabling a single operator to control multiple UAVs simultaneously (typically up to four) (Task Group HFM-078/TG-017, 2007)." Clearly, these documents establish the need for UAVs as well as the desire to put into place the capability for one person to control multiple UAVs.

This thesis will address the issues of situational awareness and how it relates to establishing an optimum ratio of operators to vehicles. It will deal only with Uninhabited Air Vehicles (UAV), a very specific class of UMVs. Despite this

narrower focus, it is anticipated that any lessons learned during the process of this thesis will also be applicable to land, surface and subsurface vehicles as well.

It is intended that this thesis is independent of any particular type or class of UAV, such as High Altitude Long Endurance (HALE), Medium Altitude Long Endurance (MALE), Tactical or any other class designator. The documents referred to above do not establish separate requirements for different classes of UAVS. Therefore, the particular aspects of multiple vehicle control discussed herein should be applicable to all classes of vehicles.

There is an apparent irony in any work concerning the human factors aspects of controlling uninhabited air vehicles. If they are truly uninhabited, where is the need to consider the human in the loop? Autonomous vehicles of all kinds are able to perform many tasks that only a few years ago seemed impossible without the involvement of human beings. Autonomous capabilities continue to advance, further reducing human involvement in dull, dirty or dangerous work. From a military point of view, this is a truly great development. If we can defend our borders, help to protect our allies and make right the wrongs of the world while limiting the threat of harm to our troops, UAVs can contribute to this end, and then UAVs will have met the goal of ensuring the safety of those charged with our collective defence. Today, UAVs patrol over Iraq, Afghanistan, and many more trouble spots around the world, providing information, security and even weapons support to troops on the ground. Some of these UAVs are controlled by operators half a world away.

The key distinction in terminology must be highlighted when UAVs are the topic of study. Uninhabited does not mean unmanned. It merely means that the human, the controlling element in the Unmanned Air System, is removed from the vehicle. “No system is unmanned” (McCauley, 2008). Due to regulatory or liability issues, some critical decisions must be made by a human (Baxter & Horn, 2005). This presents a unique set of challenges. Despite all the advances in technology that reduce the amount of interaction between the vehicle and its

pilot, there will always be at least one person to oversee the operation, launch and recover the vehicle, re-task an asset to a new target or analyze the data from the vehicle or any other of the myriad of missions that UAVs support. One of special note is weapons employment and release authority. It is this author's opinion that that any use of deadly weapons will always require a human decision maker in the loop. In order for that human to make a critical decision involving the use of deadly force, he or she must be aware of the situation involving the potential use of this force. Therein lies the critical link between human and machine. The interface must be such that the decision maker has all relevant information pertaining to the conditions where deadly force is authorized. How this information is made available to, and presented to the UAV pilot becomes the critical link in the decision making process. A similar, yet less dramatic situation exists where uninhabited vehicles occupy the same airspace with manned aircraft. Other situations certainly exist that demand a human in the command and control loop and it is not the purpose of this paper to illustrate them all. Our purpose is to delve deeper into the type of information required to enable a single operator to control several UAVs.

Unfortunately, the technological developments that aid in the automation of UAVS often place humans in roles where they are notoriously ill suited. The human must now observe and monitor the activities of the vehicle requiring sustained attention. Uninhabited air vehicles (UAVs) are of particular interest to the defence sector because they have the potential to significantly reduce the risk to aircrew in military operations (Baxter & Horn, 2005) as well as the weight and cost of aircraft.

Often, little attention, if any, is paid to the interface between man and machine until is too late to make it optimal for the person in the loop. Creating a situation or circumstances that can lead to serious errors, such as the loss of critical mission data, or loss of an opportunity to detect, track, prosecute and potentially destroy an enemy target.

UAVs have been with us, in some form or another for several years now. They are known under several different names: Unmanned Air Vehicles, Uninhabited Air Vehicles, Unmanned Air Systems, drones, etc. The intent here is not to raise a semantic argument over nomenclature, however, the “Uninhabited Air Vehicle” title is being used purposefully here, meaning that ultimately, in all systems, there is a person in the loop. This is the basis for this thesis. The pilot in the loop must be fully aware of the UAVs and their environment in order to have effective supervisory control.

B. UAV VERSUS UAS

UAV is the aircraft. It is uninhabited, semi-autonomous and controlled by an operator at some distance from the vehicle. A system is an assemblage or combinations of elements or parts forming a complex of unitary whole” (Fabrycky & Mize, 2006). The Uninhabited Air System (UAS) is the entire supporting framework and architecture that makes the mission possible, and includes all the personnel and equipment required to launch, control, recover and maintain the aircraft, as well as observe, analyze and disseminate the data coming from the vehicle. Therefore, the UAV is one integral part of the entire system. The aim of this thesis is to look at the basic elements of maintaining the situational awareness of multiple vehicles under one operator’s control.

C. SUPERVISORY CONTROL

To a large extent, operators will interact with UMVs using supervisory control, (Task Group HFM-078/TG-017, 2007) where supervisory control is analogous to the supervisor and subordinate in any work setting. Supervisors delegate tasks to subordinates, or they request services that subordinates determine how best to satisfy. In the context of UAV control, “supervisory control” means that one of more human operators are programming and receiving information from a computer that interconnects trhough artifical sensors and effectors to the controlled process or task environment” (Sheridan, 2002). In

either case, some objective or partial plan is communicated to the subordinate, perhaps along with constraints on how that objective may be achieved,but simultaneously some authority/autonomy for exactly how to achieve that objective in context is also given to the subordinate (Miller, Goldman, Funk, Wu, & Pate, 2004).

Supervisory control is central to this thesis. One operator cannot conceivably control more than one vehicle if that person is expected to control all aspects of the UAV including the joystick operations of actually flying the aircraft. The vehicle will have some form of autonomy to carry out the basic elements of the mission. The aircraft will be assigned an area of operations, usually via some form of waypoint navigation, and altitude band for operations, and an airspeed. The pilot will perform routine checks of the aircraft's systems, much like a half hourly crosscheck of instruments performed by a pilot in the flightdeck of an aircraft. It is also conceived, that for the purposes of this experiment, the aircraft would have some form of automated target recognition that would alert the operator to any target of interest.

In supervisory control, a human operator monitors a complex system state and intermittently executes some level of control on a process, acting though some automated agent (Cummings, Bruni, Mercier, & Mitchell, 2007). Due to a need to re-plan missions and reallocate under time critical and other stressful conditions, Air Traffic Contol cognitive loading provides some useful parallels that can be applied to the UAV scenario. However the air traffic control domain is not one that attempts to optimize resource allocation (planes in the air) or experiences the stress of a combat environment (Cummings & Guerlain, 2007). Borrowing from Cummings and Guerlain's definition of supervisory control for tactical Tomahawk missile and modifying it for the purposes of UAVs, supervisory control of UAVs will generally require three main tasks;

- Monitoring the [UAVs] while transiting to and from the operations area, and once in the operations area for vehicle and sensor performance for mission accomplishment, [including the search for the target],
- re-tasking of the UAVs to another area or to respond to a target of opportunity, and
- surveillance of a designated target. (Cummings & Guerlain, 2007)

A note on terminology. Throughout this work, the term pilot will be used to designate the UAV operator. It is not intended to influence the debate over who should operate UAVs. It is merely being used as a convenient term to refer to the person that has the responsibility for the operation of the UAV. No connotations are intended, nor should any be inferred by the use of the term.

II. LITERATURE REVIEW

A. APPROACHES TO MULTIPLE UAV CONTROL

Figure 1. CU-161 Sperwer Tactical UAV. (From: Canadian American Strategic Review)

Teams of support personnel including the pilots, sensor operators, launch and recovery groundcrew and maintenance personnel currently support UAV operations for the larger (HALE, MALE) type aircraft such as Global Hawk and Predator. Even small tactical UAVs such as the U.S. Army's Hunter, Shadow and Raven and the Canadian Forces Sperwer require multiple personnel, whether they are dedicated to the task of controlling the aircraft or in some way have responsibilities in support of the UAV operation. On the low end, Hunter and Shadow operations require two operators to conduct missions. An AVO (aviator operator) is responsible for aviating and navigating the UAV, while an MPO (mission payload operator) searches for targets and monitors system parameters (Dixon & Wickens, 2003). Being troops on the ground, there is significant interest in combining these two functions to one operator without significantly increasing workload. "UAVs must be controllable with much less training and while concurrently engaged in many other activities, even taking fire (Miller et al., 2004)."

Figure 2. Global Hawk UAV (From: GlobalSecurity.org)

Air Chief Marshall Sir Brian Burridge, Commander in Chief, Strike, of the Royal Air Force (RAF) described the significant manpower burden of remotely piloted operations for one of the larger UAV models. He related that 115 Flight, a RAF unit operating from Nellis AFB, operates a single Predator A Orbit in support of the coalition intelligence, surveillance and reconnaissance effort in Afghanistan. .Since the Predator can orbit for 20 hours, the unit requires three, two person crews (8 hours per crew) to operate the aircraft. Although no additional manpower numbers were specified, he also stated that analysts and data link managers supported the flying crews, while in theatre, engineers, maintenance crews, including launch and recover teams were required for aircraft operations (Task Group HFM-078/TG-017, 2007). This NATO document goes on to desribe Global Hawk teams consisting of a two person Launch and

Recover Element and a four person Mission Control Element (Task Group HFM-078/TG-017., 2007). [The] current ratios of multiple operators per vehicle will be unacceptable the near future (Miller et al., 2004).

Figure 3. RAF MQ9 Reaper UAV (From: GlobalSecurity.org)

The Applied Physics Lab of Johns Hopkins University (APL) has demonstrated the cooperative behaviors of swarms of small, autonomous UAVs. Swarm members cooperate to accomplish complex mission goals with no pilot in the loop. These projects represent a variety of approaches to UAV swarming, including teaming, consensus variables, and stigmergic potential fields. Stigmergic refers to a collaborative process using some type of coded media to guide the collaborators. The term was originally coined after the study of collaborative insects colonies who used pheramones to guide others to sources of food. It is used in the UAV context to refer to the form of encoding used between autonomous UAVs to communicate progress with respect to some collaborative task, usually searching an area for objects of interest (Elliott, 2006).

Small UAVs can be used to track vehicles, enable communications, capture signals, exfiltrate sensor data, and in their most common role, provide the war fighter a bird's-eye view of the battlefield. Individually, their effectiveness

is somewhat limited, but cooperating as a swarm, these assets can act as a distributed sensor system, employing sensors of various types and resolutions and providing different views simultaneously (Scheidt & Stipes, 2005).

Swarms also inherently provide built-in redundancy and the ability to employ several different types of sensors within a swarm to complement the intelligence collection and provide the "boots on the ground" with a better understanding of the intelligence available. For instance, a swarm equipped with both Electro-Optic and Infrared sensors (EO/IR) as well a synthetic aperture radar (SAR) could provide day night intelligence gathering to enhance the picture of the battlefield regardless of time of day or weather encountered. Several of each sensor types provides graceful degradation of intelligence gathering capability in case of attrition, whereas in the traditional employment of UAS, the loss of one aircraft is a catastrophic mission failure. The main benefit of the swarm operations concept is the opportunity for one operator, or a small team/unit to operate several UASs, increase the areas of surveillance/reconnaissance without significantly affecting the ability of the small unit to perform traditional operations by allowing the UASs to perform their functions autonomously with minimal operator input. What is not clear is to what extent the operator can and should override autonomous control in the case of targets of opportunity or system failures requiring the asset to return to base.

Mechanisms should exist for supervisory control of the assets, updating their operational picture without disturbing the search patterns of the swarm so that the integrity of the search is not affected. There also must be a capability to upgrade the swarms with inorganic intelligence to allow the swarm to optimize their search pattern without completely disrupting any searching that has occurred thus far.

If swarms represent one end of the autonomy spectrum, then small tactical UAVS represent to other end of the spectrum where the UAV only responds to the operator's control inputs, level 1 from Sheridan's Degrees of Automation (Table 1). Sheridan breaks down the degrees of automation

between a human and a robot into 8 distinct levels. It has been adapted to the UAV context by simply replacing Computer with UAV and human with pilot. The eight levels are:

1. The UAV offers no assistance: the pilot must do it all.
2. The UAV suggests alternative ways to do the task
3. The UAV selects one way to do the task and
4. executes that suggestion if the pilot approves, or
5. allows the pilot a restricted time to veto before automatic execution, or
6. executes automatically, the necessarily informs the pilot, or
7. executes automatically, then informs the pilot only if asked.
8. The UAV selects the method, executes the task, and ignores the pilot.

Table 1. A scale of degrees of automation (After: Sheridan, 2002)

The technology to enable single operator control of multiple UAVs currently exists. Boeing demonstrated the ability for one controller to operate 3 ScanEagle UAVs in 2007 (GIZMAG, 2007) and DARPA demonstrated a capability to control three tiers of aircraft (up to three heterogeneous aircraft at three different altitude bands simultaneously (Defense Update, 2007). What is not clear from these demonstrations is the workload and situational awareness that the pilot of multiple UAVs must maintain in order to effectively control the aircraft.

B. SITUATIONAL AWARENESS

> In the flight environment, the safe operation of the aircraft while achieving the mission or pilots's goals is highly dependent on a current assessment of the changing situation, including details of the aircraft's operational parameters, external conditions, navigational information, other aircraft, and hostile factors. Without this awareness (which needs to be both accurate and complete),

> the aircrew will be unable to effectively perform their functions. Indeed, as will be discussed further, even small lapses in SA can have catastrophic repercussions (Endsley, 1995a).

Endsley's definition of Situational Awareness consists of three levels: 1) the perception of the elements in the environment within a volume of time and space, 2) the comprehension of their meaning and, 3) the projection of their status in the near future (Endsley, 1995b). In the context of UAVs, we must expand that definition to include not only the pilot's volume of time and space, but also that of the UAV that the pilot is controlling. Since the UAV and the pilot form a system, then despite being separated by space, and even time zones in some cases, both volumes must be considered (Drury, Riek, & Rackliffe, 2006). Drury picks up on this theme by specifically decomposing Situational Awareness as it deals with Uninhabited Air Vehicles (UAVs). They developed a definition of HRI (Human-Robot Interaction) awareness that takes into account the asymmetric, two way nature of the awareness relationship. The definition dealt with five components of HRI, namely:

- Human-Robot
- Human-Human
- Robot-human
- Robot-Robot
- Humans overall mission awareness.

Of the five listed, of most relevance to this thesis are the Human Robot component and the Humans' Overall Mission Awareness. Drury et al.2006 defines the Human Robot interaction as "the understanding that the humans have of the locations, identities, activities, status and surroundings of the robots." She goes on to qualify this definition with "the certainty with which humans know the aforementioned information." She defines the Human's Overall Mission Awareness as "the humans understanding of the overall goals of the joint human-robot activities and the moment-by-moment measurement of the progress obtained against the goals (Drury et al., 2006)."

In a one-on-one scenario of pilot to UAV, Drury specifies the types of information required for an operator to maintain awareness of the UAV. Namely, they are the 3D spatial relationships between the UAV and:

- points on earth
- other aircraft,
- the terrain, and
- targets.

As well as 3d relationships, she further specifies predicted 3d spatial relationships, weather near the UAV, health of the UAV, status of the UAV, logic of the UAV operational threats, UAV's mission, UAV's progress towards completing the mission, and the degree to which the UAV can be trusted.

She also expands on the knowledge that the UAV must have of the pilot commands necessary to direct the UAV and the "human-delineated constraints that may require a modified course of action or command non-compliance" (Drury et al., 2006).

A large volume and complex network of information must be shared between the UAVs and the pilot. Our contention is that a dedicated Situational Awareness (SA) display is one means of achieving that shared cognition that must be achieved between pilot and robot. Our scenario only contains some aspects of Drury's interactions, namely Human-Robot and Human Overall mission awareness. The others are beyond the scope of this thesis. We believe that the SA display represents the spatial relationships between the UAV and the points on the earth, by representing, in a plan view of the geopgrhic area they are searching, all the UAVs, and by representing all the UAVs, the relative positions of all UAVs with respect to one another. Since, during the scenario, the UAVs are contolled in both altitude and airpeed, the participants will not need to control these aspects of the UAVs.

We can consider a situational Awareness display as Lens 3 in Miller and Shattuck's (2006) model, in that the Situational Awareness display presents

information above and beyond the data collected by technological systems, in this case an individual UAV, and gives information regarding all assets collecting data. The actual UAV can be considered as lens 2, the system that brings the information in from the environment.

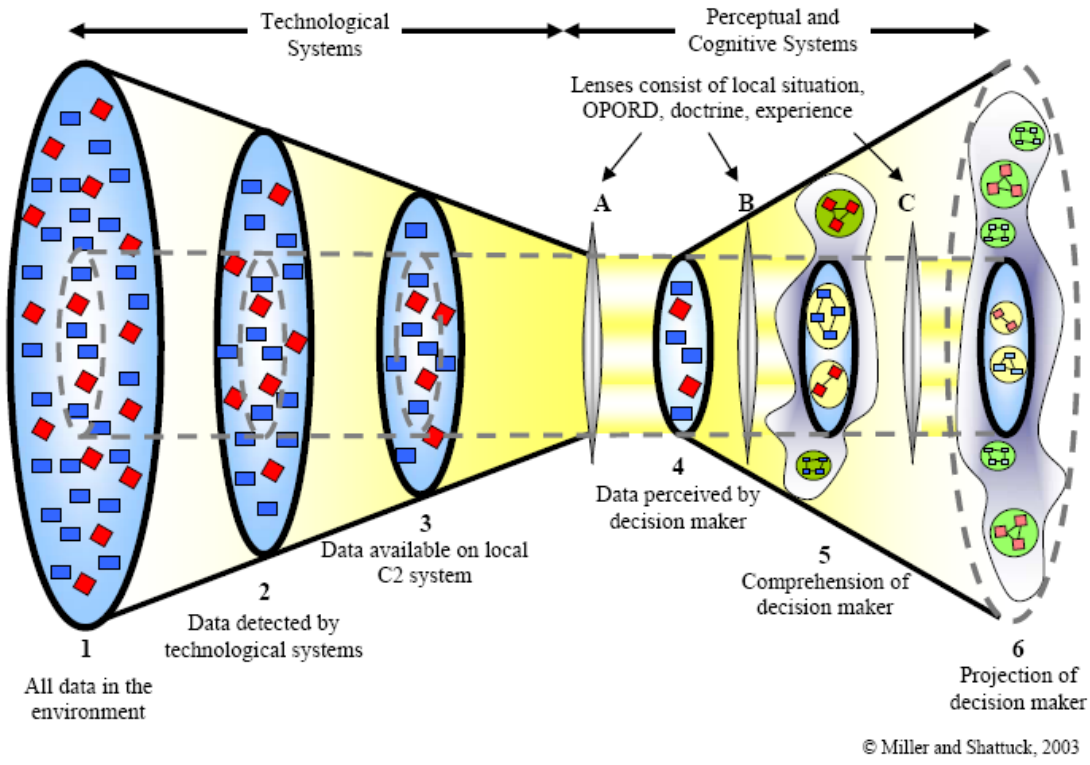

Figure 4. Miller and Shattucks' Dynamic Model of Situated Cognition (From: Lewis-Miller & Shattuck, 2006).

Lens 3, the SA display, displays the Command and Control information, much less specific than the information gathered by the onboard sensors, but nevertheless providing information critical to the coordination of assets. Using Miller and Shattuck's model and applying it to the scenario to be tested as part of this thesis, we can equate the individual UAV to lens 2 and the SA display to lens 3. Both lenses are equally important to making the decision maker's SA more complete.

C. MULTIPLE CONTROL

In one of the few papers found dealing with control of multiple platforms, Dixon and Wickens (2003) ran 36 pilots through single and dual UAV simulated military missions where the pilots were required to navigate the aircraft through the mission under three possible situations: baseline, auditory alert and auto-pilot.

The pilot tasks were mission completion, target search and systems monitoring. They found that both the auditory alert and auto-pilot conditions "improved overall performance by reducing task interference and alleviating workload" (Dixon & Wickens, 2003). The experiment dealt with two main themes, 1) to reduce the visual load on the pilot by moving some aspect of the task to the auditory channel and 2) removing the task of physically flying the aircraft to an autopilot.

In the present investigation, the participants will only exercise supervisory control of the aircraft, and not be responsible for actually piloting the aircraft. We are, in effect, freeing the pilot from any manual workload, a condition similar to using an autopilot. The situational awareness display is a means of providing the pilot with information from the aircraft environment, such as the position of the aircraft with respect to its search area and in relation to the other aircraft. The SA display is an aid to establishing the relative positions of aircraft to each other, and the geographical postion of the UAV.

D. DARPA MIXED INITIATIVE CONTROL OF AUTOMA-TEAMS (MICA)

The **Mixed Initiative Control of Automa-teams** (MICA) project of the Defense Advanced Research Projects Agency (DARPA) was intended to develop technologies that would enable one or a few war fighters to manage many teams of UAVs in an adversarial operational environment (Johnson, 2003).

> The MICA program will provide a commander in the field with the operational and mission planning tools to select optimal combinations of unmanned platforms, weapons, and sensors to form heterogeneous UAV teams with different platform capabilities and diverse payloads enabling coupled reconnaissance, strike, battle damage assessment, and force protection activities. The program is developing automated methods for real-time dynamic mission planning, mission execution, and event-driven replanning for each UAV team. We will develop collaborative teaming strategies and tactics, and cooperative team member routing to meet mission objectives. At any point in an operation, a commander or operator will be able to intervene in team operations, approve automated asset allocations and cooperative courses of action, or communicate preferences regarding team activities. Stability, performance, and robustness of team operations with an operator-in-the-loop will be emphasized during the mixed initiative dialogue between the human and unmanned air vehicles. .(Johnson, 2003)

The DARPA MICA program had the goal of demonstrating the ability of one operator to control 30 UAVs in an adversarial envoronment, with a short term goal of one operator controlling 5 UAVs within a year of program inception [2002]. Although the MICA program was subsumed by other DARPA and USAF programs, the research continued under the Joint Uninhabited Combat Air Vehicle program and now continues under several service specific programs. MICA had two areas of focus. The first was control theoretic techniques for autonomous control. The second was mixed- initiative techniques for integrating the human into the control process. The MICA progam had the rare forsight to include the Human Factors issues from the very beginning of their planning process. They concentrated on traditional cognitive engineering analysis as well as some other specialized approaches. On the cognitive engineering side, they wanted to determine the kinds of information the pilot requires to control more than one automated platform. They discuss consistency as one of the foundations of human-computer interaction. Yet, consistency is at odds with any asset operating in a hostile environment. They stressed the need to find

solutions that provided a good tradeoff between the operator's need for consistency and the platform's unpredictability requirement in order to achieve survivability (Johnson, 2003).

One of the specialized approaches within MICA is Miller's "Playbook" approach (Miller et al., 2004). He draws an analogy to sports teams that field a large number of players, with various roles to accomplish. When the coach or captain calls a play, each player knows their role and a complex series of interdependent actions known to each player takes place in a coordinated fashion to achieve the aim. Each player has some autonomy to perform their roles in the manner they best see fit, as long as each player's role is accomplished. The players can be a variety of sizes, and have specialized skills. This type of autonomy and control will be required if we are ever to achieve the goal of a single operator "controlling" multiple platforms of any type (Miller et al., 2004). From the standpoint of stiutational awareness, Miller's playbook allows the pilot to call a play, knowing what the UAVs will accomplish, without having to deal with the myriad of details about how each UAV reached its individual end state. The pilot need only know that a particular UAV has or has not completed its task and can plan the next play in order to reach the ultimate team objective.

E. DISPLAYS

Displays are the critical technology underpinning proper situational awareness for the operator. As stated by Mejdal, McCauley, and Beringer (2001) in their FAA report, "Serious attention was not given to display development until the advent of the need to fly without visual references." A similar situation exists today with UAS. Since the pilot is no longer in the flight deck, he/she can no longer rely on haptic and vestibular senses to cue them for flight characteristics. The UAS pilot must now rely on the display of the sensor and flight systems to determine the status and operation of the aircraft. This situation requires thorough thought into how information will be presented to the pilot so that

he/she can maintain full situational awareness of the aircraft's surroundings and mission. In effect, the aircraft has become the pilots avatar in a geographically separated environment (Mejdal, McCauley, & Beringer, 2001)."

This review highlights that it is not enough to simply add more information to an already "busy" display. Visual cognitive tasks approach human cognitive saturation due to the sheer volume of information available and presented to the pilot. More thoughtful analysis and layout of critical aircraft and sensor parameter information is required if we are ever to decrease the control ratio of personnel to platforms, or invert the control ratio to one operator control several platforms. It may not be enough to simply provide the pilot with a bigger display, especially if critical information is moved from foveal vision to peripheral vision where less detail can be gathered at a glance. It is hoped that the Situational Awareness display being tested will provide the essential additional information that the pilot requires to understand the environment surrounding the UAV.

During their research into secondary diplays, Chewar et al. (2002). found that "users are unable to extract information from the secondary display as effectively and/or without distracting their ability to adequately maintain primary task performance." One possible consequence for our experiment will be that the operator may not be able to adequately maintain supervisory control of the multiple UAVs unless a secondary display is used that represents geographic information for the positions of the UAVs as well as the relative position of the UAVs to each other. The assertion is that the SA display would be a secondary display, however, the participants may elect to use the SA display as the primary one, relegating the sensor views from each UAV as secondary. Another possibility is that the participants may channel their attention to one of the four UAV sensor displays, relegating the other UAVs to secondary status.

Taking into account another of Chewar et al. (2002) findings, "information should be conveyed in terms of relative position whenever possible to allow optimal probability for accurate communication and primary task sustainment (Chewar et al., 2002)." The SA display in the present study was mapped with the

layout of the UAVs displays. For example, in the experiment, the display for UAV A was in the top right hand corner of the 4-screen layout. In the SA display, the area for UAV A was in the top right hand corner, minimizing any ambiguity with repect to its location relative to the other UAVs (Chewar et al., 2002).

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III. METHOD

A. OVERVIEW

An experiment was conducted to determine whether a Situational Awareness display would increase an operator's overall knowledge of all information being gathered in a particular mission, as well as help to keep track of all the assets in a particular area. The operational question is this; will an SA display increase the Situational Awareness of an operator of multiple UAVs?

Participants were tasked with monitoring the progress of four simulated UAVs flying over imagery of the Camp Roberts, a California Nationa Guard facility frequently used by the Naval Postgraduate School for UAS research. The simulation was constructed using Google Earth as the Application Programming Interface and KML script to "fly" through the scenery from waypoint to waypoint along a specified track. Stationary ground targets were placed in the simulation in each of the UAVs search areas and the participants were tasked with keeping track of the targets, as well as the UAVs using a paper copy of the map of the area. At designated points during the simulation, the participants were asked which UAV they would task to further investigate a particular target, with the only decision criteria being that the closest UAV to the target should be deployed. The operationalization of Situational Awareness was the accuracy of their responses as well as the time taken to make the decision.

Experimental Design

The null hypothesis$_1$, H_0 is: There will be no difference in the mean error score of UAV chosen for re-deployment when the Situational Awareness display is on compared to when it is off, and the alternative hypothesis, H_A is: there will be a difference in the mean error score of the UAVs chosen for re-deployment when the Situational Awareness display is on compared to when it is off.

With regard to the response time of the operator, the null hypothesis$_2$ H_0: There will be no difference in the mean time to re-deploy the closest UAV to a target when the Situational Awareness display is on as compared to when it is off, and the alternative hypothesis, H_A is: There will be a difference in the mean time to re-deploy the closest UAV to a target when the Situational Awareness display is on compared to when it is off.

B. PARTICIPANTS

A convenience sample of voluntary participants was solicited from the student body at the Naval Postgraduate School. Potential participants from the Human Systems Integration and MOdelling, Virtual Environments and Simulations (MOVES) curriculum were solicited via email, a signup sheet on the notice board and through face to face solicitation during the MOVES Human Factors Focus Group weekly meetings. A total of 17 volunteers participated in the experiment. The first participant was intended as a pilot participant to validate the experiment method. The data was not used due to the difference in questions and question timing during participant #1's scenarios. However, the useful data gathered led to a better experiment design, including the same questions for all participants, and exact timing for each question during each of the two scenarios. Of the 16 participants, 15 were military and one civilian, 14 were male, and 2 female, aged from 25 to 46 years. Years of service among service members ranged from 2 to 21.

C. APPARATUS

The experiment ran on four identical Dell Optiplex 745 personal computers with Intel Core 2 Duo 6700 processors running at 2.66 GHz. Each system had 3 GB of RAM. All four computers used Windows XP Pro SP2 operating systems, ATI Radeon x1300/x1550 series graphics cards and ran Google Earth version 4.3. All four computers had Dell 20 inch flat panel monitors with the display settings set at 1600X1200 and colour quality set at 32 bit. The participant sat 30

inches behind the first two (lower) UAV displays. The next two UAV displays were 8 inches behind the two front displays. The Situational Awareness display appears above the four individual screens and 60 inches behind the two front displays. The Situational Awareness display presented the participant with a "plan view" of the four UAV operating areas and updates of all UAV positions. As the independent variable in the experiment, the Situational Awareness display only displayed information for one of the two scenarios each participant completed. The layout of the four individual screens was mapped with the layout of the four UAV operating areas on the Situational Awareness display. For example, UAV A appears as the top right hand side screen in the 2 X 2 layout of the UAV screens. UAV A's patrol area is shown in the top right hand side of the situational awareness display. UAV B appears in the bottom right hand side of the layout and patrols the bottom right hand side area withing the situational awareness display, and so on. (Figure 5).

Figure 5. Experiment Display Configuration

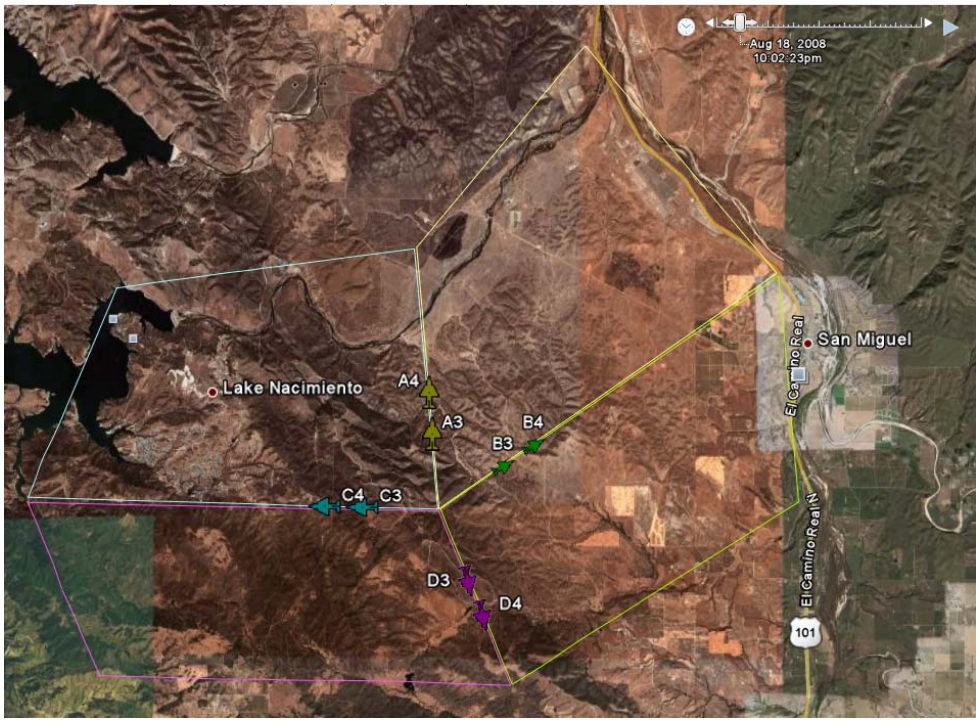


Figure 6. Situational Awareness Display – Scenario 1

Figure 7. Situational Awareness Display – Scenario 2

The Situational Awareness display was a Panasonic 50 inch (1269 mm) plasma flat screen TV, [1366(W) X 768 (H) pixels, 16:9 aspect ratio, max contrast ratio 10000:1, Horizontal scanning freq – 15-110kHz, Vertical Scanning frequency 49-120Hz] driven by a Dell Inspiron E1505 Laptop with an Intel Core 2 Duo processor @ 2.0 GHz, with 2GB RAM and running Windows XP Professional SP3. Microsoft PowerPoint displayed the Situational Awareness display due to problems running a scenario playback using Google Earth in real time. The PowerPoint slides (33 in all for each scenario) reflected the updated positions of all the UAVs at each 1 km waypoint. The PowerPoint show timing coincided with the arrival of all four UAVs at the next waypoint, so that as they arrived, the SA display updated each UAV to the new position. The slide show was timed using the slide show auto advance feature set to the appropriate amount of time it took the UAVs to navigate from one waypoint to another, which varied from 41 to 48 seconds.

1. Scenario Development

The experiment scenario was developed using Google Earth™. The area chosen for operation was the Camp Roberts and surrounding area near San Luis Obispo along the central California coast. The rational for choosing this area is the fact that the Naval Postgraduate School routinely uses this area to run their quarterly Tactical Network Topology (TNT) exercise (Ferrari, 2006). This is a multidisciplinary experiment that uses UAVs either directly in the experiment or to support some of the research objectives. It is felt that by using the same geographic area, the commonality could lead to an easier transition from this virtual world to experimentation in the actual world in follow-up research.

Figure 8. Placemark Icon in Google earth

The Camp Roberts training area in this virtual world was divided into four areas that the virtual UAVs would patrol. The common point among all four areas was the intersection of Tower and Ayer Rd. The waypoints for the simulated UAV were created using the “add a Placemark” function, by either selecting the “map Pin” icon from the toolbar above the map portion of the screen, or by selecting the ADD> Place mark menu. A new place mark window appears, as well as a place mark in the center of the map display. The place mark was selected using the mouse and dragged to the desired position. The Scroll, Pan and Zoom functions at the top right hand corner of the map display also created the desired viewing angles. Once the desired viewing angle is achieved, the user selected the “Snapshot current view” button in the “add a new Placemark” window. Alternatively, theses viewing angles could be entered manual into the data field found in the “new placemark” window.

A series of these place marks was created in the desired order of progression, numbered waypoint 1 (A1, B1, C1 and D1) through waypoint 32 (A32, B32, C32, D32) for each UAV in the scenario. In addition to the waypoint label, the decimal Latitude and Longitude of the waypoint also appeared behind the waypoint name to indicate the actual position of the waypoint. The camera angle for the simulated UAV was set using the Tilt field for all waypoints. To set these fields, the view tab under the properties selection for each waypoint was set as follows: A tilt of 65º was set for all waypoints. This view is equivalent to viewing a scene looking 15º below the horizon (90º views the horizon and a tilt of 0º views directly beneath the UAV). The range field was set to 300 metres for all waypoints. This process afforded the same relative view of all waypoints in the simulation and gave the impression of flying over the various waypoints along the route of each UAV. The speed of advance of the simulated UAV was controlled through the Tools > Options menu in Google Earth. To achieve a simulated flying speed of 85 kilometres per hour, the Fly-To Speed and Tour Speed fields under the Touring tab were set to 0.025 and the Tour Pause was set to 0.

By making these settings, we were, in effect controlling our simulated UAVs for altitude, airspeed and heading. Our virtual autopilot enabled a scenario where the pilot could provide supervisory control of the aircraft in the simulation.

During the course of the scenario, the participants were asked relevant questions to ascertain their knowledge of the location of each UAV with respect to a particular stationary ground target in the scenario.

The Situational Awareness display was also built in Google Earth. It was originally intended to be a dynamic display run concurrently with the sensor views of each of the four UAVs in the scenario. However, since Google Earth is the API for the .kml file constructed for the playback, and it has limited user control over the speed of playback, the speed of the playback could not be accurately matched to the speed of advance of the UAVs from one waypoint to the next. The skeleton of the input file was provided by Dr. Eugene Baurokov from the IS dept. at NPS, shown here:

```
<?xml version="1.0" encoding="UTF-8"?>
<kml xmlns="http://earth.google.com/kml/2.0">
<Folder>
<name>UAV_A</name>
<Style>
<IconStyle>
<Icon><href>http://IP_PLACE_HOLDER/Images/SAicons/uav_blue.gif
</href></Icon>
</IconStyle>
<BalloonStyle>
<text>$[description]
</text>
</BalloonStyle>
</Style>
<description><![CDATA[<br>as of 7/11/2008 11:45:44 AM (PST)<br><a
href="http://IP_PLACE_HOLDER/Images/SApictures/rascals.jpg">View
picture</a><br>]]>
</description>
<Point><coordinates>-120.806023,35.713182,300</coordinates></Point>
<TimeSpan><begin>0</begin><end>1</end></TimeSpan>
</Folder>
</kml>
```

His original version was modified to accurately reflect the timeline desired for the scenario and to build in some aspects that were necessary for this simulation. Waypoint one for all UAVs appears below. The amended code appears as follows:

```
<?xml version="1.0" encoding="UTF-8"?>
<kml xmlns="http://earth.google.com/kml/2.0">
<Folder>
<name>SA</name>
<!--******************** 1st POSITION ALL UAVs*********************************  -->
<name>A1</name>
<Style>
        <IconStyle>
                <Icon><href>A_North.png</href></Icon>
        </IconStyle>
        <BalloonStyle>
                <text>$[description]</text>
        </BalloonStyle>
        <description><![CDATA[<br>as of 18/8/2008 14:00:00 PM (PST)<br>]]>
        </description>
        <Point><coordinates>-120.806023,35.713182,300</coordinates></Point>
        <TimeSpan><begin>2008-08-18T22:00:00Z</begin><end>2008-08-
18T22:01:24Z</end></TimeSpan>

        <name>B1</name>
                        <Icon><href>b_050.png</href></Icon>
        <description><![CDATA[<br>as of 18/8/2008 14:00:00 PM (PST)<br>]]>
        </description>
        <Point><coordinates>-120.805293,35.712721,300</coordinates></Point>
        <TimeSpan><begin>2008-08-18T22:00:00Z</begin><end>2008-08-
18T22:01:24Z</end></TimeSpan>

        <name>C1</name>
                        <Icon><href>c_270.png</href></Icon>
        <description><![CDATA[<br>as of 18/8/2008 14:00:00PM (PST)<br>]]>
        </description>
        <Point><coordinates>-120.806224,35.713203,300</coordinates></Point>
        <TimeSpan><begin>2008-08-18T22:00:00Z</begin><end>2008-08-
18T22:01:24Z</end></TimeSpan>
```

```
        <name>D1</name>
                        <Icon><href>d_170.png</href></Icon>
        <description><![CDATA[<br>as of 18/8/2008 14:00:00 PM (PST)<br>]]>
        </description>
        <Point><coordinates>-120.805876,35.712634,300</coordinates></Point>
        <TimeSpan><begin>2008-08-18T22:00:00Z</begin><end>2008-08-
18T22:01:24Z</end></TimeSpan>

</Folder>
</kml>
```

NOTE: Placemarks 2 through 32 removed for brevity. Please see Annex A for full coding of the SA display (Scenario 2) and Annex B for Scenario 1.

The kml format is essentially a pared down version of XML. The critical elements are the Time Span and Time Tag. However, as previously mentioned, the playback within Google Earth could not be slowed to real time in order for it to be used for playback. Screen captures from the playback were copied and pasted into the PowerPoint slide show.

The ICONS for the UAVs were taken from the Cenetix database, courtesy of Dr. Eugene Baurokov of the IS dept at the Naval Postgraduate School. The icons were modified using the GNU Image Manipulation Program (GIMP) version 2.2.14. Much trial and error was required to modify the icons. A separate colour was chosen for each route, with yellow corresponding with Route A, green with route B, blue icons for route C and purple icons fro route D. However, once the original UAV was modified for colour, the .gif icons would not display properly in the Google Earth simulation. Although the icons appeared in the animation, a white square background would also appear around them. After several attempts using various image formats, the .”png” format proved compatible with Google Earth. The icons were then modified for heading so that they would point in the direction of travel. The icons were modified into several different versions, each representing a direction that the UAV would head at various points in the simulation. This was important to effect some realism to the simulation. However, the .png format would not allow the rotation of the icon to the desired

heading. After more trial and error, a procedure was established to modify the colour and heading of the icons while preserving the transparent back. The original .gif icon was opened using the GIMP software. The icons heading and/or colour was modified. This icon was copied and saved into a new image window where it had the transparent background re-applied and was saved as a .png file. The step by step procedure to modify the icons for use in Google Earth can be found in Annex C.

Figure 9. SA display aircraft Icons

D. PROCEDURE

Volunteers were assigned a participant number on a first come, first served basis. For example, the person who showed up for the first available time slot became participant #1, and so on. A 2 X 2 Latin Square was constructed using the two scenarios (1 and 2) and two treatments (SA turned on and SA turned off) to assure a non-biased, pseudo-random assignment of scenarios and treatments to minimize any order or learning effects based on the order of presentations of the scenarios and SA display. A sample of assignment matrix follows:

Participant Latin Square Assignment		
Part	Scene	SA
1	1	n
	2	y
2	1	y
	2	n
3	2	n
	1	y
4	2	y
	1	n

Participant Latin Square Assignment		
Part	Scene	SA
5	1	n
	2	y
6	1	y
	2	n
7	2	n
	1	y
8	2	y
	1	n
9	1	n
	2	y
10	1	y
	2	n
11	2	n
	1	y
12	2	y
	1	n
13	1	n
	2	y
14	1	y
	2	n
15	2	n
	1	y
16	2	y
	1	n
17	1	n
	2	y

Table 2. Latin Square participant assignment matrix.

The cycle repeats itself for participants 5 through 8 and then again for #9 through 312 and so on.

Upon arrival, the participant's read and signed the informed consent document, as per NPS Institutional Review Board regulations. The participants also filled out a pre-experiment questionnaire to gather demographic data as well as determine their level of experience with flight operations and map use in tactical scenarios. The participants received verbal instructions (Appendix F).

The participants were tasked with providing supervisory control of four UAVs patrolling assigned search areas. Sitting at a desk in front of the displays and using a paper map of the area, they were tasked to keep track of stationary targets they detected on the ground and the position of all the UAVs. The UAVs moved through the scene at 85 km per hour and an altitude of 300 metres above the ground from waypoint to waypoint without participant interaction. The targets were deliberately large, to avoid having the experiment become one of target detection. Each waypoint was marked in the scene with a waypoint name, decimal latitude and longitude and a “map pin” as desribed in the Scenario Development section.

The view on each of the UAV displays represented a simulated view from the camera onboard the UAV. (Figure 10).

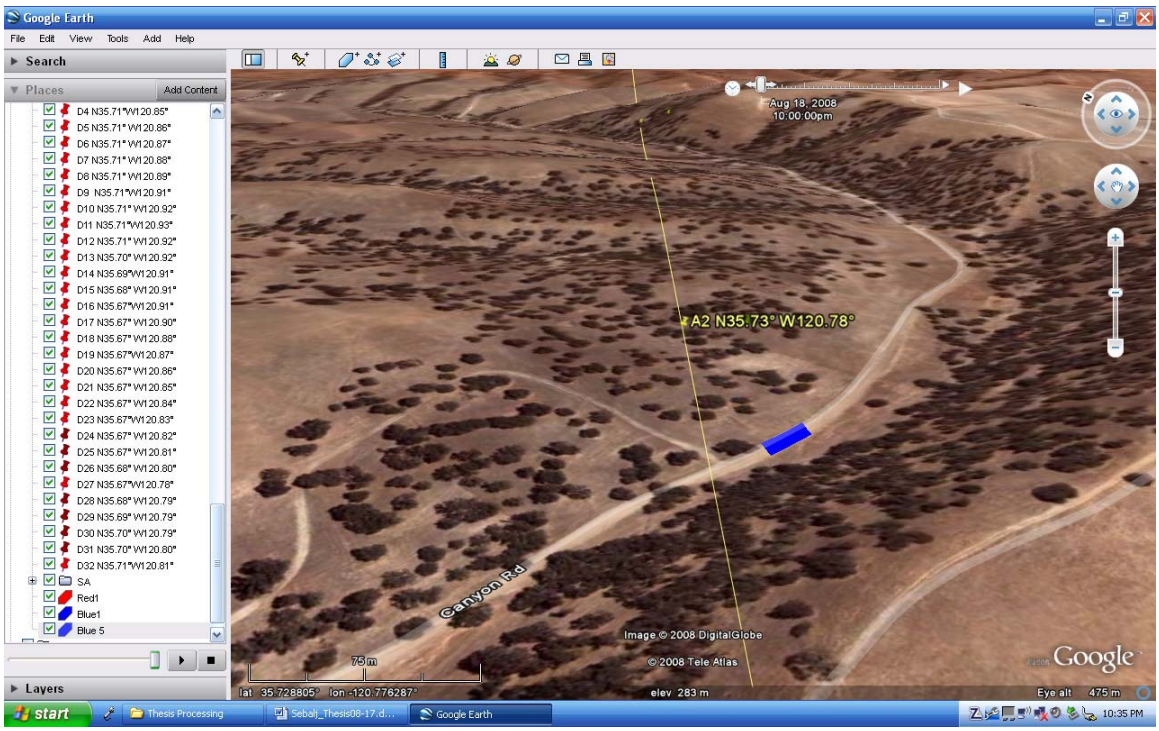


Figure 10. UAV Camera Display with “blue” target.

Each scenario took approximately 22 minutes to complete. At pre-determined points during each scenario, the participants were asked one of six questions concerning which UAV they would chose to re-assign from the current flight plan to further investigate one of the previously detected targets. For example: You must reinvestigate the Blue target between found between Waypoint C6 and C7. Which closest UAV should you dispatch?

Answer	____	C-A-B-D
Confidence	____	
Turn	____	Left all

The correct answers were pre-calculated and appear following the blanks, in this case, C-A-B-D, with C being the closest UAV to the target, A the next closest, B, the third closest and D the farthest from the named target.

Once all six scenario questions were asked and answered, the scenario was terminated.

IV. RESULTS

The participants received an error score based on the difference between the closest UAV to the designated target at the time of the question and the UAV chosen. The lowest possible score was zero when they chose the closest UAV to the target, and the maximum score varied by the scenario, with the maximum possible score of 10.93 km in Scenario 2 question 4. The maximum score awarded was 10.32 km in Scenario 2 Question 5. The participants responses were also timed using a Timex Ironman Writwatch Chronograph. The chronograph was started immediately following the experimenters questions and stopped when the choice of UAV was stated. Following their initial UAV choice, the participants were also asked for a confidence rating of their response, High, Medium or Low and the direction, Left or Right that they would execute a turn of the chosen UAV towards the target. The confidence and turn direction answers were not timed. The rationale for these questions will be further examined in the discussion section. All data was analyzed using JMP7 statistical analysis software (SAS Institute Inc., 2007).

A. MEAN ERROR SCORE

The null and alternative hypotheses were:

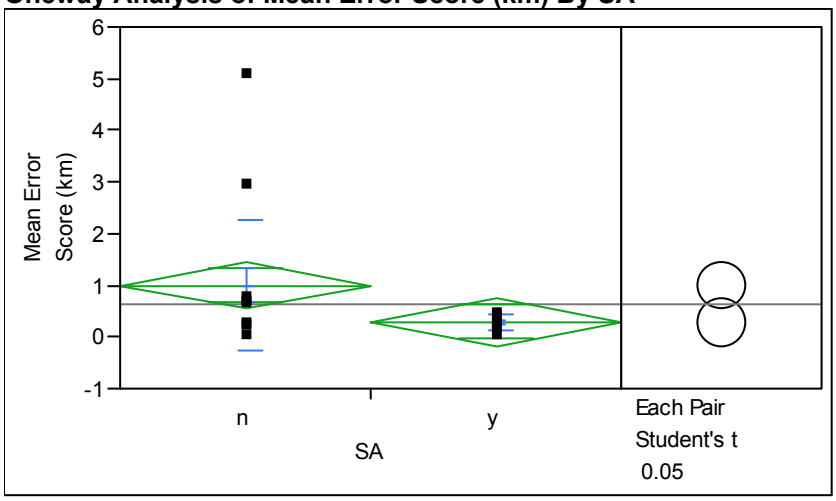
H_0: There will be no difference in the mean error score of UAV chosen for re-deployment when the Situational Awareness display is on compared to when it is off.

H_A: There will be a difference in the mean error score of the UAVs chosen for re-deployment when the Situational Awareness display is on compared to when it is off.

A paired T- Test was conducted on the difference in the mean error score received when the Situational Awareness display was available and when it was not. Based on the results analyzed using JMP7 we must reject the null

hypothesis. An analysis of the results reveals that re-assigning the correct UAVs to monitor a particular target was significantly different when the Situational Awareness display was on compared to when it was off $t(32) = 2.04$, $p = .0424$. The mean error score in the no-SA trial was 1.0 km (SD = 1.28) and in the SA trial was 0.29 km (SD = .15). The error score was reduced by 71% when using the Situational Awareness display.

Oneway Analysis of Mean Error Score (km) By SA



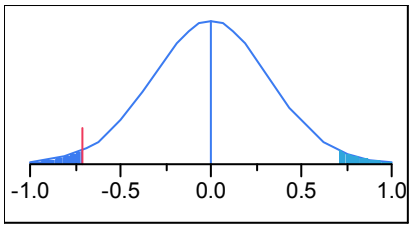
Oneway Anova
Summary of Fit

Rsquare	0.14021
Adj Rsquare	0.111551
Root Mean Square Error	0.911652
Mean of Response	0.645938
Observations (or Sum Wgts)	32

t Test
y-n

Assuming equal variances

Difference	-0.7129	t Ratio	-2.21184
Std Err Dif	0.3223	DF	30
Upper CL Dif	-0.0547	Prob > |t|	0.0347
Lower CL Dif	-1.3712	Prob > t	0.9826
Confidence	0.95	Prob < t	0.0174



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
SA	1	4.066001	4.06600	4.8923	0.0347
Error	30	24.933287	0.83111		
C. Total	31	28.999289			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
n	16	1.00240	0.22791	0.5369	1.4679
y	16	0.28948	0.22791	-0.1760	0.7549

Std Error uses a pooled estimate of error variance

Means and Std Deviations

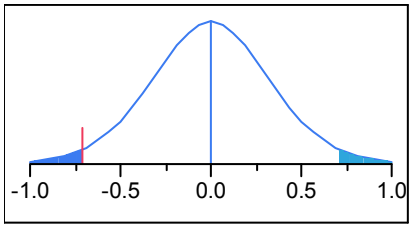
Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
n	16	1.00240	1.28002	0.32001	0.32032	1.6845
y	16	0.28948	0.15416	0.03854	0.20733	0.3716

t Test

y-n

Assuming unequal variances

Difference	-0.7129	t Ratio	-2.21184
Std Err Dif	0.3223	DF	15.43506
Upper CL Dif	-0.0276	Prob > |t|	0.0424
Lower CL Dif	-1.3982	Prob > t	0.9788
Confidence	0.95	Prob < t	0.0212



Means Comparisons

Comparisons for each pair using Student's t

t	Alpha
2.04227	0.05

Abs(Dif)-LSD	n	y
n	-0.65826	0.05466
y	0.05466	-0.65826

Positive values show pairs of means that are significantly different.

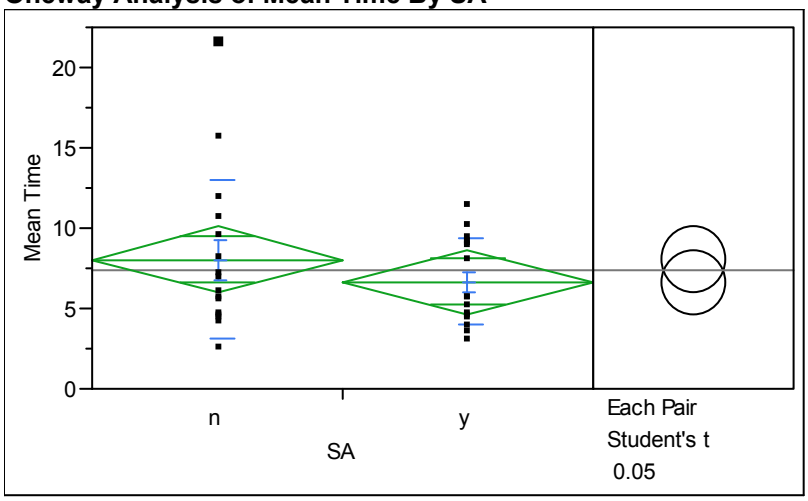
1. Mean Time

H_0: There will be no difference in the mean time to re-deploy the closest UAV to a target when the Situational Awareness display is on as compared to when it is off.

H_A: There will be a difference in the mean time to re-deploy the closest UAV to a target when the Situational Awareness display is on compared to when it is off.

No significant difference was found in the decision time to re-deploy a UAV to a target of interest between having the SA display on or off, t(32) = -1.0, p = .3249. The mean decision time in the no SA trial was 8.04 (SD = 4.93) and in the SA trail was 6.63 (SD = 2.70). Further, power analysis reveals that the Least Significant Number (LSN) for this experiment is 125 and the Least Significant Value is 2.97. Therefore, a minimum of 125 participants would be required to have a 50% probability of finding a significant difference in decision time. Using the existing sample size and variances, the sensitivity of this analysis is that differences of less than 2.97 seconds are not detectable.

Oneway Analysis of Mean Time By SA



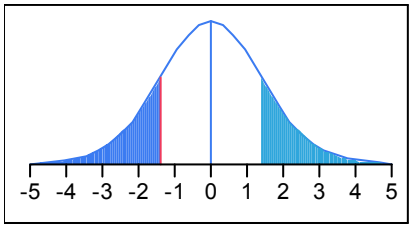
Oneway Anova
Summary of Fit

Rsquare	0.032314
Adj Rsquare	5.768e-5
Root Mean Square Error	3.973924
Mean of Response	7.338542
Observations (or Sum Wgts)	32

t Test
y-n

Assuming equal variances

Difference	-1.4063	t Ratio	-1.00089
Std Err Dif	1.4050	DF	30
Upper CL Dif	1.4631	Prob > |t|	0.3249
Lower CL Dif	-4.2756	Prob > t	0.8376
Confidence	0.95	Prob < t	0.1624



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
SA	1	15.82031	15.8203	1.0018	0.3249
Error	30	473.76215	15.7921		
C. Total	31	489.58247			

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
n	16	8.04167	4.93007	1.2325	5.4146	10.669
y	16	6.63542	2.69789	0.6745	5.1978	8.073

Means Comparisons
Comparisons for each pair using Student's t

t	Alpha
2.04227	0.05

Abs(Dif)-LSD	n	y
n	-2.8694	-1.4631
y	-1.4631	-2.8694

Positive values show pairs of means that are significantly different.

Power Details
Test
SA

Power

α	σ	δ	Number	Power
0.0500	3.973924	0.703125	32	0.1626

Least Significant Number

α	σ	δ	Number(LSN)
0.0500	3.973924	0.703125	125.1547

Least Significant Value

α	σ	Number	LSV
0.0500	3.973924	32	2.869381

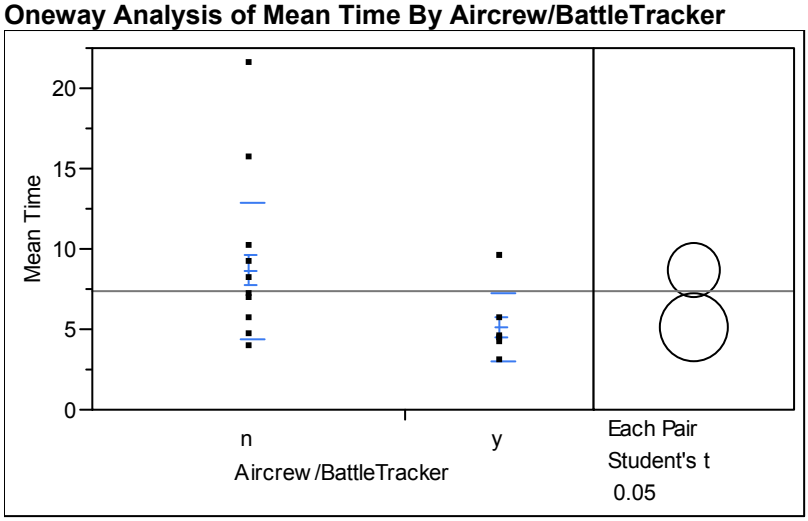
B. DISCUSSION

Since there was no significant difference in the time taken to make a decision about which UAV to re-deploy, some analysis was conducted in an attempt to rule out learning effect or asymmetric transfer of learning. The results were re-analyzed and grouped based on whether they received the SA display on the first or second run. The mean difference for decision time between the first scenario and second scenario was calculated. In the group that received the SA display on the first scenario, the average length of time for decisions made during the second run was longer; Mean +2.40 seconds, SD 3.86. In the group that received the SA display on the second scenario, the average time to make a decision during the second scenario was shorter; Mean -.42 seconds, SD 3.87. Both results were as expected. When the SA display was available during the first run, the time to reassign lengthened on the second run. When the SA display was available during the second scenario, the average time for the second scenario decreased. Although the Standard Deviation was quite high for both cases, we can conclude that the experimental design and Latin Cube randomization of treatments minimized any asymmetric transfer of training.

When the results were divided into separate groups based on participant experience as aircrew (pilots, navigators, Non-flying officers) or those with battle tracking experience, there was a significant difference in time to answer the questions versus those who did not have job experience in those areas. This information was gathered via the pre-experiment questionnaire. All scenario responses were analyzed (not stratified into SA and non-SA scenarios). The six participants, who were aircrew or had battle tracking experience, had a mean response time of 5.51 seconds for both treatments, with a standard deviation of

2.15 seconds. The 10 participants without such experience had a mean response time of 8.65 seconds for both treatments with a standard deviation of 4.27 seconds. The t ratio was 2.04 with a p <.0023.

Fit Y by X Group
Oneway Analysis of Mean Time By Aircrew/BattleTracker



Means and Std Deviations

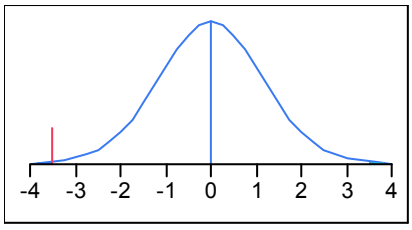
Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
n	20	8.65000	4.27453	0.95581	6.6495	10.651
y	12	5.15278	2.14671	0.61970	3.7888	6.517

t Test

y-n

Assuming unequal variances

Difference	-3.4972	t Ratio	-3.07009
Std Err Dif	1.1391	DF	29.36761
Upper CL Dif	-1.1687	Prob > |t|	0.0046
Lower CL Dif	-5.8257	Prob > t	0.9977
Confidence	0.95	Prob < t	0.0023



Means Comparisons
Comparisons for each pair using Student's t

t	Alpha
2.04227	0.05

Abs(Dif)-LSD	n	y
n	-2.3519	0.7815
y	0.7815	-3.0363

Positive values show pairs of means that are significantly different.

This result prompted a re-analysis of the time to respond data comparing the SA and non-SA scenarios to determine if partitioning the aircrew/battle tracker group of participants from all others might lend some insight into why no difference in response time was found. However, once again, no statistical significance could be found in time to respond with this further partitioning.

When considering the background and training of the majority of participants, this result should not be surprising. Those trained in any type of operational occupation, such as aircrew, infantrymen, armoured corps, surface warfare officers, etc. must make decisions. Often, they are trained to do so with very limited information and in time critical scenarios. Conventional military wisdom, to quote General George S. Patton Jr. is: “A good plan executed today is much better than a perfect plan executed at some indefinite point in the future.” During the experiment, the only mention of time criticality was made during the instructions to the participants, when they were instructed that their answer to the experimenter’s question would be timed, and that all UAV re-tasking decisions had to be made prior to the UAVs reaching the next waypoint. However, there was no significant time difference for decision made with or without the Situational Awareness display. It is not unreasonable to expect that these participants (all but one military officers) would be prepared to make a decision as quickly as possible. If this is indeed the case, then perhaps it was naïve to believe that with predominantly military participants we could expect to see a significant time difference in decisions made with and without the SA display.

C. RELATING THE RESULTS TO HUMAN-UAV AWARENESS

The Situational Awareness display in this experiment demonstrated Drury’s Human Robot interaction since, through the use of the SA display, our participants were better able to task the closest UAV to a target that required further investigation. Hence, the participants better knew the locations of all the UAVs and were able to make better assignments based on the criteria presented to them. It also allowed the participants to have some sense of projecting the

scenario forward and know, at some point in the near future, where the UAVs would be, filling the criteria laid out by Endsley. Because of the simplicity of the experiment, only two of Drury's 5 Human Robot Interaction Awareness components could be tested, Human-Robot interaction and the Human's overall mission awareness. Through the SA display, the participants displayed a better knowledge of the locations of the UAVs and the targets.

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V. CONCLUSIONS

Based on this experiment, providing a Situational Awareness (SA) display to the operator of multiple UAVs will lead to a more accurate assignment of the closest UAV to reinvestigate a particular target when compared to not having a Situational Awareness display. In a general sense, this means that a situational awareness display will help an operator of multiple UAVs know, at a glance, where the aircraft are in relation to each other and geographically, allowing them to make better employment decisions. Future research can test this concept in field conditions, with small UAVs and trained operators to confirm our results.

The simulation utilized in this experiment did not allow for the actual re-tasking of assets to investigate the targets of interest. The capability to do so would add further realism into the scenario. By changing the mission of one or more of the UAVs from a search mission to a reconnaissance mission the pilot would have to fully exercise supervisory control and periodically change the level of autonomy given to the UAV. This would add complexity and realism for the pilot, further testing the ability to maintain the awareness required for mission accomplishment. As well, the scenarios developed for this experiment kept all of the UAVs in adjacent areas, with simple flight plans. It is not improbable that a pilot could be responsible for UAVs in geographically separated areas, with each UAV conducting optimized search patterns based on the terrain and targets, confusing the 3D relationships between UAV and pilot and challenging the ability to maintain overall mission awareness. Adding this type of realism to future scenarios and experiemtn apparatus could help to understand the type of situational awareness display necessary to push the control ratio towards more vehicles per pilot.

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APPENDIX A. XML CODE FOR GOOGLE EARTH SITUATIONAL AWARENESS DISPLAY – SCENARIO 2.

Please note: For the sake of brevity, only the .kml code for the frist group of Situational Awareness Icons appear as intact code. Following the first group (A1, B1, C1, D1) only the lines of code that are different (i.e., name, Icon, descrition, coordinates and time span) from one block to another are shown.

```
<?xml version="1.0" encoding="UTF-8"?>
<kml xmlns="http://earth.google.com/kml/2.0">
<Folder>
<name>SA</name>
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                </BalloonStyle>
        </Style>
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</Placemark>

<Placemark>
        <name>B1</name>
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                </IconStyle>
                <BalloonStyle>
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<Placemark>
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<!-- ********************** 5th POSITION ALL UAVs************************** -->
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<!-- ********** 6th POSITION ALL UAVs********** -->
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]]></description>
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<TimeSpan><begin>2008-08-18T22:05:36Z </begin><end>2008-08-18T22:07:00Z</end></TimeSpan>

<name>B9</name>
<Icon><href>b_050.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:05:36 PM (PST)
]]></description>
<Point><coordinates>-120.746007, 35.690775,300</coordinates></Point>

<TimeSpan><begin>2008-08-18T22:05:36Z </begin><end>2008-08-18T22:07:00Z</end></TimeSpan>

<name>C9</name>
<Icon><href>c_270.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:05:36 PM (PST)
]]></description>
<Point><coordinates>-120.835837, 35.773107,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:05:36Z </begin><end>2008-08-18T22:07:00Z</end></TimeSpan>

<name>D9</name>
<Icon><href>d_270.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:05:36 PM (PST)
]]></description>
<Point><coordinates>-120.905779, 35.714208,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:05:36Z </begin><end>2008-08-18T22:07:00Z</end></TimeSpan>

<!-- ********** 10th POSITION ALL UAVs********** -->
<name>A10</name>
<Icon><href>a_330.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:06:18PM (PST)
]]></description>
<Point><coordinates>-120.705419, 35.769777,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:06:18Z </begin><end>2008-08-18T22:07:42Z</end></TimeSpan>

<name>B10</name>
<Icon><href>b_050.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:06:18 PM (PST)
]]></description>
<Point><coordinates>-120.736617,35.695523,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:06:18Z </begin><end>2008-08-18T22:07:42Z</end></TimeSpan>

<name>C10</name>
<Icon><href>c_270.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:06:18 PM (PST)
]]></description>
<Point><coordinates>-120.846835,35.771987,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:06:18Z </begin><end>2008-08-18T22:07:42Z</end></TimeSpan>

<name>D10</name>
<Icon><href>d_270.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:06:18 PM (PST)
]]></description>
<Point><coordinates>-120.916806,35.714352,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:06:18Z </begin><end>2008-08-18T22:07:42Z</end></TimeSpan>

!-- ********** 11th POSITION ALL UAVs********** -->
<name>A11</name>
<Icon><href>a_330.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:07:00PM (PST)
]]></description>
<Point><coordinates>-120.712347, 35.776421,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:07:00Z </begin><end>2008-08-18T22:08:24Z</end></TimeSpan>

<name>B11</name>
<Icon><href>b_050.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:07:00 PM (PST)
]]></description>
<Point><coordinates>-120.727257, 35.700287,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:07:00Z </begin><end>2008-08-18T22:08:24Z</end></TimeSpan>

<name>C11</name>
<Icon><href>c_270.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:07:00 PM (PST)
]]></description>

<Point><coordinates>-120.857604, 35.770819,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:07:00Z </begin><end>2008-08-18T22:08:24Z</end></TimeSpan>

<name>D11</name>
<Icon><href>d_170.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:07:00 PM (PST)
]]></description>
<Point><coordinates>-120.927970, 35.714552,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:07:00Z </begin><end>2008-08-18T22:08:24Z</end></TimeSpan>
<!-- ********** 12th POSITION ALL UAVs********** -->
<name>A12</name>
<Icon><href>a_330.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:07:42PM (PST)
]]></description>
<Point><coordinates>-120.719493, 35.783375,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:07:42Z </begin><end>2008-08-18T22:09:06Z</end></TimeSpan>

<name>B12</name>
<Icon><href>b_050.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:07:42 PM (PST)
]]></description>
<Point><coordinates>-120.717831, 35.705067,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:07:42Z </begin><end>2008-08-18T22:09:06Z</end></TimeSpan>

<name>C12</name>
<Icon><href>c_270.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:07:42 PM (PST)
]]></description>
<Point><coordinates>-120.868753, 35.769639,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:07:42Z </begin><end>2008-08-18T22:09:06Z</end></TimeSpan>

<name>D12</name>
<Icon><href>d_170.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:07:42 PM (PST)
]]></description>
<Point><coordinates>-120.923613,35.706350,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:07:42Z </begin><end>2008-08-18T22:09:06Z</end></TimeSpan>

<!-- ********** 13th POSITION ALL UAVs********** -->
<name>A13</name>
<Icon><href>a_330.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:08:24PM (PST)
]]></description>
<Point><coordinates>-120.726657, 35.790237,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:08:24Z </begin><end>2008-08-18T22:09:48Z</end></TimeSpan>

<name>B13</name>
<Icon><href>b_050.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:08:24 PM (PST)
]]></description>
<Point><coordinates>-120.708393, 35.709786,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:08:24Z </begin><end>2008-08-18T22:09:48Z</end></TimeSpan>

<name>C13</name>
<Icon><href>c_270.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:08:24PM (PST)
]]></description>
<Point><coordinates>-120.879525, 35.768435,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:08:24Z </begin><end>2008-08-18T22:09:48Z</end></TimeSpan>

<name>D13</name>
<Icon><href>d_170.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:08:24 PM (PST)
]]></description>

<Point><coordinates>-120.919306,35.698005,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:08:24Z </begin><end>2008-08-18T22:09:48Z</end></TimeSpan>

<!-- ********** 14th POSITION ALL UAVs********** -->
<name>A14</name>
<Icon><href>a_330.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:09:06PM (PST)
]]></description>
<Point><coordinates>-120.733747, 35.797099,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:09:06Z </begin><end>2008-08-18T22:10:30Z</end></TimeSpan>

<name>B14</name>
<Icon><href>b_north.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:09:06PM (PST)
]]></description>
<Point><coordinates>-120.699189, 35.714649,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:09:06Z </begin><end>2008-08-18T22:10:30Z</end></TimeSpan>

<name>C14</name>
<Icon><href>c_270.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:09:06 PM (PST)
]]></description>
<Point><coordinates>-120.890737, 35.767305,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:09:06Z </begin><end>2008-08-18T22:10:30Z</end></TimeSpan>

<name>D14</name>
<Icon><href>d_170.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:09:06 PM (PST)
]]></description>
<Point><coordinates>-120.914796,35.689834,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:09:06Z </begin><end>2008-08-18T22:10:30Z</end></TimeSpan>

<!-- ********** 15th POSITION ALL UAVs********** -->
<name>A15</name>
<Icon><href>a_330.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:09:48PM (PST)
]]></description>
<Point><coordinates>-120.740965, 35.803967,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:09:48Z </begin><end>2008-08-18T22:11:12Z</end></TimeSpan>

<name>B15</name>
<Icon><href>b_north.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:09:48 PM (PST)
]]></description>
<Point><coordinates>-120.700051, 35.724070,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:09:48Z </begin><end>2008-08-18T22:11:12Z</end></TimeSpan>

<name>C15</name>
<Icon><href>c_205.png</href></Icon>
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as of 18/8/2008 14:09:48PM (PST)
]]></description>
<Point><coordinates>-120.901772, 35.765756,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:09:48Z </begin><end>2008-08-18T22:11:12Z</end></TimeSpan>

<name>D15</name>
<Icon><href>d_170.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:09:48 PM (PST)
]]></description>
<Point><coordinates>-120.910394,35.681458,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:09:48Z </begin><end>2008-08-18T22:11:12Z</end></TimeSpan>

<!-- ********** 16th POSITION ALL UAVs********** -->
<name>A16</name>

<Icon><href>a_330.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:10:30PM (PST)
]]></description>
<Point><coordinates>-120.748049, 35.810837,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:10:30Z </begin><end>2008-08-18T22:11:54Z</end></TimeSpan>

<name>B16</name>
<Icon><href>b_north.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:10:30PM (PST)
]]></description>
<Point><coordinates>-120.701092, 35.733069,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:10:30Z </begin><end>2008-08-18T22:11:54Z</end></TimeSpan>

<name>C16</name>
<Icon><href>c_205.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:10:30 PM (PST)
]]></description>
<Point><coordinates>-120.906222, 35.757468,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:10:30Z </begin><end>2008-08-18T22:11:54Z</end></TimeSpan>

<name>D16</name>
<Icon><href>d_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:10:30PM (PST)
]]></description>
<Point><coordinates>-120.906284, 35.673131,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:10:30Z </begin><end>2008-08-18T22:11:54Z</end></TimeSpan>

<!-- ************************** 17th POSITION ALL UAVs************************ -->
<name>A17</name>
<Icon><href>a_330.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:11:12PM (PST)
]]></description>
<Point><coordinates>-120.755294, 35.817712,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:11:12Z </begin><end>2008-08-18T22:12:36Z</end></TimeSpan>

<name>B17</name>
<Icon><href>b_north.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:11:12PM (PST)
]]></description>
<Point><coordinates>-120.702094, 35.742070,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:11:12Z </begin><end>2008-08-18T22:12:36Z</end></TimeSpan>

<name>C17</name>
<Icon><href>c_205.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:11:12PM (PST)
]]></description>
<Point><coordinates>-120.910420, 35.749028,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:11:12Z </begin><end>2008-08-18T22:12:36Z</end></TimeSpan>

<name>D17</name>
<Icon><href>d_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:11:12PM (PST)
]]></description>
<Point><coordinates>-120.895341, 35.673045,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:11:12Z </begin><end>2008-08-18T22:12:36Z</end></TimeSpan>

<!-- ********************** 18th POSITION ALL UAVs********************** -->
<name>A18</name>
<Icon><href>a_230.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:11:54PM (PST)
]]></description>
<Point><coordinates>-120.762411, 35.824742,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:11:54Z </begin><end>2008-08-18T22:13:18Z</end></TimeSpan>

<name>B18</name>
<Icon><href>b_north.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:11:54PM (PST)
]]></description>
<Point><coordinates>-120.703050, 35.751117,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:11:54Z </begin><end>2008-08-18T22:13:18Z</end></TimeSpan>

<name>C18</name>
<Icon><href>c_205.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:11:54PM (PST)
]]></description>
<Point><coordinates>-120.914681, 35.740809,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:11:54Z </begin><end>2008-08-18T22:13:18Z</end></TimeSpan>

<name>D18</name>

con><href>d_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:11:54PM (PST)
]]></description>
<Point><coordinates>-120.884406, 35.672876,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:11:54Z </begin><end>2008-08-18T22:13:18Z</end></TimeSpan>

<!-- ********** 19th POSITION ALL UAVs********** -->
<name>A19</name>
<Icon><href>a_230.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:12:36PM (PST)
]]></description>
<Point><coordinates>-120.769592, 35.817780,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:12:36Z </begin><end>2008-08-18T22:14:00Z</end></TimeSpan>

<name>B19</name>
<Icon><href>b_north.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:12:36PM (PST)
]]></description>
<Point><coordinates> -120.703971, 35.759995,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:12:36Z </begin><end>2008-08-18T22:14:00Z</end></TimeSpan>

<name>C19</name>
<Icon><href>c_205.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:12:36PM (PST)
]]></description>
<Point><coordinates>-120.919071, 35.732546,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:12:36Z </begin><end>2008-08-18T22:14:00Z</end></TimeSpan>

<name>D19</name>
<Icon><href>d_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:12:36PM (PST)
]]></description>
<Point><coordinates>-120.873208, 35.672598,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:12:36Z </begin><end>2008-08-18T22:14:00Z</end></TimeSpan>

<!-- ********** 20th POSITION ALL UAVs********** -->
<name>A20</name>
<Icon><href>a_230.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:13:18PM (PST)
]]></description>
<Point><coordinates>-120.776650, 35.810887,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:13:18Z </begin><end>2008-08-18T22:14:42Z</end></TimeSpan>

<name>B20</name>
<Icon><href>b_230.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:13:18PM (PST)
]]></description>
<Point><coordinates>-120.704964, 35.769050,300</coordinates></Point>

<TimeSpan><begin>2008-08-18T22:13:18Z </begin><end>2008-08-18T22:14:42Z</end></TimeSpan>

<name>C20</name>
<Icon><href>c_205.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:13:18PM (PST)
]]></description>
<Point><coordinates>-120.923441, 35.724154,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:13:18Z </begin><end>2008-08-18T22:14:42Z</end></TimeSpan>

<name>D20</name>
<Icon><href>d_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:13:18PM (PST)
]]></description>
<Point><coordinates>-120.862119, 35.672429,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:13:18Z </begin><end>2008-08-18T22:14:42Z</end></TimeSpan>

!-- ********** 21st POSITION ALL UAVs********** -->
<name>A21</name>
<Icon><href>a_230.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:14:00PM (PST)
]]></description>
<Point><coordinates>-120.783846, 35.803903,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:14:00Z </begin><end>2008-08-18T22:15:24Z</end></TimeSpan>

<name>B21</name>
<Icon><href>b_230.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:14:00PM (PST)
]]></description>
<Point><coordinates>-120.713998, 35.764002,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:14:00Z </begin><end>2008-08-18T22:15:24Z</end></TimeSpan>

<name>C21</name>
<Icon><href>c_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:14:00PM (PST)
]]></description>
<Point><coordinates>-120.928008,35.715823,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:14:00Z </begin><end>2008-08-18T22:15:24Z</end></TimeSpan>

<name>D21</name>
<Icon><href>d_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:14:00PM (PST)
]]></description>
<Point><coordinates>-120.851043, 35.672259,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:14:00Z </begin><end>2008-08-18T22:15:24Z</end></TimeSpan>

<!-- ********** 22nd POSITION ALL UAVs********** -->
<name>A22</name>
<Icon><href>a_230.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:14:42PM (PST)
]]></description>
<Point><coordinates>-120.791018, 35.797016,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:14:42Z </begin><end>2008-08-8T22:16:06Z</end></TimeSpan>

e>B22</name>
<Icon><href>b_230.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:14:42PM (PST)
]]></description>
<Point><coordinates>-120.723134, 35.758902,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:14:42Z </begin><end>2008-08-18T22:16:06Z</end></TimeSpan>

<name>C22</name>
<Icon><href>c_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:14:42PM (PST)
]]><description>

<Point><coordinates>-120.916895, 35.715361,300</coordinates></Point><TimeSpan>
<begin>2008-08-8T22:14:42Z </begin><end>2008-08-18T22:16:06Z</end></TimeSpan>

<name>D22</name>
<Icon><href>d_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:14:42PM (PST)
]]></description>
<Point><coordinates>-120.840023, 35.672127,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:14:42Z </begin><end>2008-08-18T22:16:06Z</end></TimeSpan>

!-- ********** 23rd POSITION ALL UAVs********** -->
<name>A23</name>
<Icon><href>a_230.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:15:24PM (PST)
]]></description>
<Point><coordinates>-120.798129, 35.790057,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:15:24Z </begin><end>2008-08-18T22:16:48Z</end></TimeSpan>

<name>B23</name>
<Icon><href>b_230.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:15:24PM (PST)
]]></description>
<Point><coordinates>-120.732254, 35.753776,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:15:24Z </begin><end>2008-08-18T22:16:48Z</end></TimeSpan>

<name>C23</name>
<Icon><href>c_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:15:24PM (PST)
]]></description>
<Point><coordinates>-120.905813,35.715168,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:15:24Z </begin><end>2008-08-18T22:16:48Z</end></TimeSpan>

<name>D23</name>
<Icon><href>d_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:15:24PM (PST)
]]></description>
<Point><coordinates>-120.828966,35.671824,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:15:24Z </begin><end>2008-08-8T22:16:48Z</end></TimeSpan>

<!-- ********** 24th POSITION ALL UAVs********** -->
<name>A24</name>
<Icon><href>a_230.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:16:06PM (PST)
]]></description>
<Point><coordinates>-120.805291, 35.783175,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:16:06Z </begin><end>2008-08-18T22:17:30Z</end></TimeSpan>

<name>B24</name>
<Icon><href>b_230.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:16:06PM (PST)
]]><description>
<Point><coordinates>-120.741345, 35.748685,300</coordinates></Point>
<TimeSpan><begin>2008-08-8T22:16:06Z </begin><end>2008-08-18T22:17:30Z</end></TimeSpan>

<name>C24</name>
<Icon><href>c_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:16:06PM (PST)
]]></description>
<Point><coordinates>-120.894799, 35.714926,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:16:06Z </begin><end>2008-08-18T22:17:30Z</end></TimeSpan>

<name>D24</name>
<Icon><href>d_090.png</href></Icon>

<description><![CDATA[
as of 18/8/2008 14:16:06PM (PST)
]]></description>
<Point><coordinates>-120.817883, 35.671715,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:16:06Z </begin><end>2008-08-18T22:17:30Z</end></TimeSpan>

!-- ********** 25th POSITION ALL UAVs********** -->
<name>A25</name>
<Icon><href>a_180.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:16:48PM (PST)
]]></description>
<Point><coordinates>-120.812549, 35.776040,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:16:48Z </begin><end>2008-08-18T22:18:12Z</end></TimeSpan>

<name>B25</name>
<Icon><href>b_230.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:16:48PM (PST)
]]></description>
<Point><coordinates>-120.750524, 35.743514,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:16:48Z </begin><end>2008-08-18T22:18:12Z</end></TimeSpan>

<name>C25</name>
<Icon><href>c_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:16:48PM (PST)
]]></description>
<Point><coordinates>-120.883731, 35.714724,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:16:48Z </begin><end>2008-08-18T22:18:12Z</end></TimeSpan>

<name>D25</name>
<Icon><href>d_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:16:48PM (PST)
]]></description>
<Point><coordinates>-120.807000, 35.671405,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:16:48Z </begin><end>2008-08-18T22:18:12Z</end></TimeSpan>

<!-- ********** 26th POSITION ALL UAVs********** -->
<name>A26</name>
<Icon><href>a_180.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:17:30PM (PST)
]]>
</description>
<Point><coordinates>-120.811603, 35.767136,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:17:30Z </begin><end>2008-08-18T22:18:54Z</end></TimeSpan>

<name>B26</name>
<Icon><href>b_230.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:17:30PM (PST)
]]><desscription>
<Point><coordinates>-120.759572, 35.738475,300</coordinates></Point><TimeSpan>
<begin>2008-08-8T22:17:30Z </begin><end>2008-08-18T22:18:54Z</end></TimeSpan>

<name>C26</name>
<Icon><href>c_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:17:30PM (PST)
]]></description>
<Point><coordinates>-120.872773, 35.714558,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:17:30Z </begin><end>2008-08-18T22:18:54Z</end></TimeSpan>

<name>D26</name>
<Icon><href>d_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:17:30PM (PST)
]]></description>
<Point><coordinates>-120.795770, 35.671280,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:17:30Z </begin><end>2008-08-18T22:18:54Z</end></TimeSpan>

<!-- ********** 27th POSITION ALL UAVs********** -->
<name>A27</name>
<Icon><href>a_180.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:18:12PM (PST)
]]></description>
<Point><coordinates>-120.810611, 35.757940,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:18:12Z </begin><end>2008-08-18T22:19:36Z</end></TimeSpan>

<name>B27</name>
<Icon><href>b_230.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:18:12PM (PST)
]]></description>
<Point><coordinates>-120.768898, 35.733418,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:18:12Z </begin><end>2008-08-18T22:19:364Z</end></TimeSpan>

<name>C27</name>
<Icon><href>c_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:18:12PM (PST)
]]></description>
<Point><coordinates>-120.861702, 35.714216,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:18:12Z </begin><end>2008-08-18T22:19:36Z</end></TimeSpan>

<name>D27</name>
<Icon><href>d_330.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:18:12PM (PST)
]]></description>
<Point><coordinates>-120.784727, 35.670944,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:18:12Z </begin><end>2008-08-18T22:19:36Z</end></TimeSpan>

<!-- ********** 28th POSITION ALL UAVs********** -->
<name>A28</name>
<Icon><href>a_180.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:18:54PM (PST)
]]></description>
<Point><coordinates>-120.809686,35.749064,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:18:54Z </begin><end>2008-08-18T22:20:18Z</end></TimeSpan>

<name>B28</name>
<Icon><href>b_230.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:18:54PM (PST)
]]></description>
<Point><coordinates>-120.777975, 35.728334,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:18:54Z </begin><end>2008-08-18T22:20:18Z</end></TimeSpan>

<name>C28</name>
<Icon><href>c_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:18:54PM (PST)
]]></description>
<Point><coordinates>-120.850541, 35.713998,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:18:54Z </begin><end>2008-08-18T22:20:18Z</end></TimeSpan>

<name>D28</name>
<Icon><href>d_330.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:18:54PM (PST)
]]></description>
<Point><coordinates>-120.788937, 35.679233,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:18:54Z </begin><end>2008-08-18T22:20:18Z</end></TimeSpan>

<!-- ********** 29th POSITION ALL UAVs********** -->
<name>A29</name>
<Icon><href>a_180.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:19:36PM (PST)
]]></description>
<Point><coordinates>-120.808854, 35.741133,300</coordinates></Point>

<TimeSpan><begin>2008-08-18T22:19:36Z </begin><end>2008-08-18T22:21:00Z</end></TimeSpan>

<name>B29</name>
con><href>b_230.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:19:36PM (PST)
]]></description>
<Point><coordinates>-120.787031, 35.723216,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:19:36Z </begin><end>2008-08-18T22:21:00Z</end></TimeSpan>

<name>C29</name>
<Icon><href>c_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:19:36PM (PST)
]]></description>
<Point><coordinates>-120.839477,35.713761,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:19:36Z </begin><end>2008-08-18T22:21:00Z</end></TimeSpan>

<name>D29</name>
<Icon><href>d_330.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:19:36PM (PST)
]]></description>
<Point><coordinates>-120.793182, 35.687565,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:19:36Z </begin><end>2008-08-18T22:21:00Z</end></TimeSpan>

<!-- ********** 30th POSITION ALL UAVs********** -->
<name>A30</name>
<Icon><href>a_180.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:20:18PM (PST)
]]></description>
<Point><coordinates>-120.807877, 35.731168,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:20:18Z </begin><end>2008-08-18T22:21:42Z</end></TimeSpan>

<name>B30</name>
<Icon><href>b_230.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:20:18PM (PST)
]]></description>
<Point><coordinates>-120.796394, 35.718165,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:20:18Z </begin><end>2008-08-18T22:21:42Z</end></TimeSpan>

<name>C30</name>
<Icon><href>c_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:20:18PM (PST)
]]></description>
<Point><coordinates>-120.828341,35.713569,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:20:18Z </begin><end>2008-08-18T22:21:42Z</end></TimeSpan>

<name>D30</name>
<Icon><href>d_330.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:20:18PM (PST)
]]></description>
<Point><coordinates>-120.797475, 35.695894,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:20:18Z </begin><end>2008-08-18T22:21:42Z</end></TimeSpan>

<!-- ********** 31st POSITION ALL UAVs********** -->
<name>A31</name>
<Icon><href>a_180.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:21:00PM (PST)
]]></description>
<Point><coordinates>-120.806929,35.722192,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:21:00Z </begin><end>2008-08-18T22:21:42Z</end></TimeSpan>

<name>B31</name>
<Icon><href>b_175.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:21:00PM (PST)
]]></description>

<Point><coordinates>-120.805293,35.712721,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:21:00Z </begin><end>2008-08-18T22:21:42Z</end></TimeSpan>

<name>C31</name>
con><href>c_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:21:00PM (PST)
]]></description>
<Point><coordinates>-120.817233, 35.713279,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:21:00Z </begin><end>2008-08-18T22:21:42Z</end></TimeSpan>
<name>D31</name>
<Icon><href>d_330.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:21:00PM (PST)
]]></description>
<Point><coordinates>-120.801979, 35.704191,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:21:00Z </begin><end>2008-08-18T22:21:42Z</end></TimeSpan>

<!-- ********** 32nd POSITION ALL UAVs********** -->
<name>A32</name>
<Icon><href>a_180.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:21:42PM (PST)
]]></description>
<Point><coordinates>-120.806023,35.713182,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:21:42Z </begin><end>2008-08-18T22:22:24Z</end></TimeSpan>

<name>B32</name>
<Icon><href>b_175.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:21:42PM (PST)
]]></description>
<Point><coordinates>-120.801098, 35.704681,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:21:42Z </begin><end>2008-08-18T22:22:24Z</end></TimeSpan>

<name>C32</name>
<Icon><href>c_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:21:42PM (PST)
]]></description>
<Point><coordinates>-120.806224,35.713203,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:21:42Z </begin><end>2008-08-18T22:22:24Z</end></TimeSpan>

<name>D32</name>
<Icon><href>d_330.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:21:42PM (PST)
]]></description>
<Point><coordinates>-120.805876,35.712634,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:21:42Z </begin><end>2008-08-18T22:22:24Z</end></TimeSpan>
</Folder>
</kml>

APPENDIX B. XML CODE FOR GOOGLE EARTH SITUATIONAL AWARENESS DISPLAY – SCENARIO 1

Please note: For the sake of brevity, only the .kml code for the frist group of Situational Awareness Icons appear as intact code. Following the first group (A1, B1, C1, D1) only the lines of code that are different (i.e., name, Icon, descrition, coordinates and time span) are shown.

```
<?xml version="1.0" encoding="UTF-8"?>
<kml xmlns="http://earth.google.com/kml/2.0">

<Folder>

<name>SA</name>

<!-- ***************************** 1st POSITION ALL UAVs*****************************  -->

<Placemark>
        <name>A1</name>
        <Style>
                <IconStyle>
                        <Icon><href>A_North.png</href></Icon>
                </IconStyle>
                <BalloonStyle>
                        <text>$[description]</text>
                </BalloonStyle>
        </Style>
        <description><![CDATA[<br>as of 18/8/2008 14:00:00 PM (PST)<br>]]>
        </description>
        <Point><coordinates>-120.806023,35.713182,300</coordinates></Point>
        <TimeSpan><begin>2008-08-18T22:00:00Z</begin>
                <end>2008-08-18T22:01:24Z</end></TimeSpan>
</Placemark>

<Placemark>
        <name>B1</name>
        <Style>
                <IconStyle>
                        <Icon><href>b_050.png</href></Icon>
                </IconStyle>
                <BalloonStyle>
                        <text>$[description]</text>
                </BalloonStyle>
        </Style>
        <description><![CDATA[<br>as of 18/8/2008 14:00:00 PM (PST)<br>]]>
        </description>
        <Point><coordinates>-120.805293,35.712721,300</coordinates></Point>
```

```
        <TimeSpan><begin>2008-08-18T22:00:00Z</begin>
                <end>2008-08-18T22:01:24Z</end></TimeSpan>
</Placemark>

<Placemark>
        <name>C1</name>
        <Style>
                <IconStyle>
                        <Icon><href>c_270.png</href></Icon>
                </IconStyle>
                <BalloonStyle>
                        <text>$[description]</text>
                </BalloonStyle>
        </Style>
        <description><![CDATA[<br>as of 18/8/2008 14:00:00PM (PST)<br>]]>
        </description>
        <Point><coordinates>-120.806224,35.713203,300</coordinates></Point>
        <TimeSpan><begin>2008-08-18T22:00:00Z</begin>
                <end>2008-08-18T22:01:24Z</end></TimeSpan>
</Placemark>

<Placemark>
        <name>D1</name>
        <Style>
                <IconStyle>
                        <Icon><href>d_170.png</href></Icon>
                </IconStyle>
                <BalloonStyle>
                        <text>$[description]</text>
                </BalloonStyle>
        </Style>
        <description><![CDATA[<br>as of 18/8/2008 14:00:00 PM (PST)<br>]]>
        </description>
        <Point><coordinates>-120.805876,35.712634,300</coordinates></Point>
        <TimeSpan><begin>2008-08-18T22:00:00Z</begin>
                <end>2008-08-18T22:01:24Z</end></TimeSpan>
</Placemark>

<!-- ***************************** 2nd POSITION ALL UAVs***************************** -->
<name>A2</name>
<Icon><href>A_North.png</href></Icon>
<description><![CDATA[<br>as of 18/8/2008 14:00:42PM (PST)<br>]]></description>
<Point><coordinates>-120.806929,35.722192,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:00:42Z </begin><end>2008-08-18T22:02:06Z</end></TimeSpan>

<name>B2</name>
<Icon><href>b_050.png</href></Icon>
<description><![CDATA[<br>as of 18/8/2008 14:00:42 PM (PST)<br>]]></description>
<Point><coordinates>-120.796394, 35.718165,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:00:42Z </begin><end>2008-08-18T22:02:06Z</end></TimeSpan>

<name>C2</name>
<Icon><href>c_270.png</href></Icon>
<description><![CDATA[<br>as of 18/8/2008 14:00:42 PM (PST)<br>]]></description>
```

<Point><coordinates>-120.817233, 35.713279,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:00:42Z </begin><end>2008-08-18T22:02:06Z</end></TimeSpan>

<name>D2</name>
<Icon><href>d_170.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:00:42 PM (PST)
]]></description>
<Point><coordinates>-120.801979, 35.704191,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:00:42Z </begin><end>2008-08-18T22:02:06Z</end></TimeSpan>

<!-- ********** 3rd POSITION ALL UAVs********** -->
<name>A3</name>
<Icon><href>A_North.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:01:24 PM (PST)
]]></description>
<Point><coordinates>-120.807877, 35.731168,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:01:24Z </begin><end>2008-08-18T22:02:48Z</end></TimeSpan>

<name>B3</name>
<Icon><href>b_050.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:01:24 PM (PST)
]]></description>
<Point><coordinates>-120.787031, 35.723216,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:01:24Z </begin><end>2008-08-18T22:02:48Z</end></TimeSpan>

<name>C3</name>
<Icon><href>c_270.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:01:24 PM (PST)
]]></description>
<Point><coordinates>-120.828341,35.713569,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:01:24Z </begin><end>2008-08-18T22:02:48Z</end></TimeSpan>

<name>D3</name>
<Icon><href>d_170.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:01:24 PM (PST)
]]></description>
<Point><coordinates>-120.797475, 35.695894,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:01:24Z </begin><end>2008-08-18T22:02:48Z</end></TimeSpan>

<!-- ********** 4th POSITION ALL UAVs********** -->
<name>A4</name>
<Icon><href>A_North.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:02:06PM (PST)
]]></description>
<Point><coordinates>-120.808854, 35.741133,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:02:06Z </begin><end>2008-08-18T22:03:30Z</end></TimeSpan>

<name>B4</name>
<Icon><href>b_050.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:02:06 PM (PST)
]]></description>
<Point><coordinates>-120.777975, 35.728334,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:02:06Z </begin><end>2008-08-18T22:03:30Z</end></TimeSpan>

<name>C4</name>
<Icon><href>c_270.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:02:06 PM (PST)
]]></description>
<Point><coordinates>-120.839477,35.713761,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:02:06Z </begin><end>2008-08-18T22:03:30Z</end></TimeSpan>

<name>D4</name>
<Icon><href>d_170.png</href></Icon>

<description><![CDATA[
as of 18/8/2008 14:02:06 PM (PST)
]]></description>
<Point><coordinates>-120.793182, 35.687565,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:02:06Z </begin><end>2008-08-18T22:03:30Z</end></TimeSpan>

<!-- ********** 5th POSITION ALL UAVs********** -->
<name>A5</name>
<Icon><href>A_North.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:02:48PM (PST)
]]></description>
<Point><coordinates>-120.809686,35.749064,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:02:48Z </begin><end>2008-08-18T22:04:12Z</end></TimeSpan>

<name>B5</name>
<Icon><href>b_050.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:02:48 PM (PST)
]]></description>
<Point><coordinates>-120.768898, 35.733418,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:02:48Z </begin><end>2008-08-18T22:04:12Z</end></TimeSpan>

<name>C5</name>
<Icon><href>c_270.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:02:48 PM (PST)
]]></description>
<Point><coordinates>-120.850541, 35.713998,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:02:48Z </begin><end>2008-08-18T22:04:12Z</end></TimeSpan>

<name>D5</name>
<Icon><href>d_170.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:02:48 PM (PST)
]]></description>
<Point><coordinates>-120.788937, 35.679233,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:02:48Z </begin><end>2008-08-18T22:04:12Z</end></TimeSpan>

<!-- ********** 6th POSITION ALL UAVs********** -->
<name>A6</name>
<Icon><href>A_North.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:03:30PM (PST)
]]></description>
<Point><coordinates>-120.810611, 35.757940,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:03:30Z </begin><end>2008-08-18T22:04:54Z</end></TimeSpan>

<name>B6</name>
<Icon><href>b_050.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:03:30 PM (PST)
]]></description>
<Point><coordinates>-120.759572, 35.738475,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:03:30Z </begin><end>2008-08-18T22:04:54Z</end></TimeSpan>

<name>C6</name>
<Icon><href>c_270.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:03:30 PM (PST)
]]></description>
<Point><coordinates>-120.861702, 35.714216,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:03:30Z </begin><end>2008-08-18T22:04:54Z</end></TimeSpan>

<name>D6</name>
<Icon><href>d_270.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:03:30 PM (PST)
]]></description>
<Point><coordinates>-120.784727, 35.670944,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:03:30Z </begin><end>2008-08-18T22:04:54Z</end></TimeSpan>
<!-- **********7th POSITION ALL UAVs********** -->
<name>A7</name>

<Icon><href>A_North.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:04:12PM (PST)
]]></description>
<Point><coordinates>-120.811603, 35.767136,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:04:12Z </begin><end>2008-08-18T22:05:36Z</end></TimeSpan>

<name>B7</name>
<Icon><href>b_050.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:04:12 PM (PST)
]]></description>
<Point><coordinates>-120.750524, 35.743514,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:04:12Z </begin><end>2008-08-18T22:05:36Z</end></TimeSpan>

<name>C7</name>
<Icon><href>c_270.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:04:12 PM (PST)
]]></description>
<Point><coordinates>-120.872773, 35.714558,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:04:12Z </begin><end>2008-08-18T22:05:36Z</end></TimeSpan>

<name>D7</name>
<Icon><href>d_270.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:04:12 PM (PST)
]]></description>
<Point><coordinates>-120.795770, 35.671280,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:04:12Z </begin><end>2008-08-18T22:05:36Z</end></TimeSpan>

<!-- ********** 8h POSITION ALL UAVs********** -->
<name>A8</name>
<Icon><href>a_045.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:04:54PM (PST)
]]></description>
<Point><coordinates>-120.812549, 35.776040,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:04:54Z </begin><end>2008-08-18T22:06:18Z</end></TimeSpan>

<name>B8</name>
<Icon><href>b_050.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:04:54 PM (PST)
]]></description>
<Point><coordinates>-120.741345, 35.748685,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:04:54Z </begin><end>2008-08-18T22:06:18Z</end></TimeSpan>

<name>C8</name>
<Icon><href>c_270.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:04:54PM (PST)
]]></description>
<Point><coordinates>-120.883731, 35.714724,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:04:54Z </begin><end>2008-08-18T22:06:18Z</end></TimeSpan>

<name>D8</name>
<Icon><href>d_270.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:04:54 PM (PST)
]]></description>
<Point><coordinates>-120.807000, 35.671405,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:04:54Z </begin><end>2008-08-18T22:06:18Z</end></TimeSpan>

<!-- ********** 9h POSITION ALL UAVs********** -->
<name>A9</name>
<Icon><href>a_045.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:05:36PM (PST)
]]></description>
<Point><coordinates>-120.805291, 35.783175,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:05:36Z </begin><end>2008-08-18T22:07:00Z</end></TimeSpan>

<name>B9</name>
<Icon><href>b_050.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:05:36 PM (PST)
]]></description>
<Point><coordinates>-120.732254, 35.753776,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:05:36Z </begin><end>2008-08-18T22:07:00Z</end></TimeSpan>

<name>C9</name>

con><href>c_270.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:05:36 PM (PST)
]]></description>
<Point><coordinates>-120.894799, 35.714926,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:05:36Z </begin><end>2008-08-18T22:07:00Z</end></TimeSpan>

<name>D9</name>
<Icon><href>d_270.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:05:36 PM (PST)
]]></description>
<Point><coordinates>-120.817883, 35.671715,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:05:36Z </begin><end>2008-08-18T22:07:00Z</end></TimeSpan>

<!-- ************************** 10th POSITION ALL UAVs************************ -->
<name>A10</name>
<Icon><href>a_045.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:06:18PM (PST)
]]></description>
<Point><coordinates>-120.798129, 35.790057,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:06:18Z </begin><end>2008-08-18T22:07:42Z</end></TimeSpan>

<name>B10</name>
<Icon><href>b_050.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:06:18 PM (PST)
]]></description>
<Point><coordinates>-120.723134, 35.758902,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:06:18Z </begin><end>2008-08-18T22:07:42Z</end></TimeSpan>

<name>C10</name>
<Icon><href>c_270.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:06:18 PM (PST)
]]></description>
<Point><coordinates>-120.905813, 35.715168,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:06:18Z </begin><end>2008-08-18T22:07:42Z</end></TimeSpan>

<name>D10</name>
<Icon><href>d_270.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:06:18 PM (PST)
]]></description>
<Point><coordinates>-120.828966,35.671824,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:06:18Z </begin><end>2008-08-18T22:07:42Z</end></TimeSpan>

<!-- ********************** 11th POSITION ALL UAVs************************ -->
<name>A11</name>
<Icon><href>a_045.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:07:00PM (PST)
]]></description>
<Point><coordinates>-120.791018, 35.797016,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:07:00Z </begin><end>2008-08-18T22:08:24Z</end></TimeSpan>

<name>B11</name>
<Icon><href>b_050.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:07:00 PM (PST)
]]></description>
<Point><coordinates>-120.713998, 35.764002,300</coordinates></Point>

<TimeSpan><begin>2008-08-18T22:07:00Z </begin><end>2008-08-18T22:08:24Z</end></TimeSpan>

<name>C11</name>
<Icon><href>c_270.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:07:00 PM (PST)
]]></description>
<Point><coordinates>-120.916895, 35.715361,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:07:00Z </begin><end>2008-08-18T22:08:24Z</end></TimeSpan>

<name>D11</name>
con><href>d_270.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:07:00 PM (PST)
]]></description>
<Point><coordinates>-120.840023, 35.672127,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:07:00Z </begin><end>2008-08-18T22:08:24Z</end></TimeSpan>

<!-- ********** 12th POSITION ALL UAVs********** -->
<name>A12</name>
<Icon><href>a_045.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:07:42PM (PST)
]]></description>
<Point><coordinates>-120.783846, 35.803903,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:07:42Z </begin><end>2008-08-18T22:09:06Z</end></TimeSpan>

<name>B12</name>
<Icon><href>b_175.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:07:42 PM (PST)
]]></description>
<Point><coordinates>-120.704964, 35.769050,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:07:42Z </begin><end>2008-08-18T22:09:06Z</end></TimeSpan>

<name>C12</name>
<Icon><href>c_025.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:07:42 PM (PST)
]]></description>
<Point><coordinates>-120.928008,35.715823,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:07:42Z </begin><end>2008-08-18T22:09:06Z</end></TimeSpan>

<name>D12</name>
<Icon><href>d_270.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:07:42 PM (PST)
]]></description>
<Point><coordinates>-120.851043, 35.672259,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:07:42Z </begin><end>2008-08-18T22:09:06Z</end></TimeSpan>

<!-- ********** 13th POSITION ALL UAVs********** -->
<name>A13</name>
<Icon><href>a_045.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:08:24PM (PST)
]]></description>
<Point><coordinates>-120.776650, 35.810887,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:08:24Z </begin><end>2008-08-18T22:09:48Z</end></TimeSpan>

<name>B13</name>
<Icon><href>b_175.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:08:24 PM (PST)
]]></description>
<Point><coordinates> -120.703971, 35.759995,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:08:24Z </begin><end>2008-08-18T22:09:48Z</end></TimeSpan>

<name>C13</name>
<Icon><href>c_025.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:08:24PM (PST)
]]></description>

<Point><coordinates>-120.923441, 35.724154,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:08:24Z </begin><end>2008-08-18T22:09:48Z</end></TimeSpan>

<name>D13</name>
<Icon><href>d_270.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:08:24 PM (PST)
]]></description>
<Point><coordinates>-120.862119, 35.672429,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:08:24Z </begin><end>2008-08-18T22:09:48Z</end></TimeSpan>

!-- ********** 14th POSITION ALL UAVs********** -->
<name>A14</name>
<Icon><href>a_045.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:09:06PM (PST)
]]></description>
<Point><coordinates>-120.769592, 35.817780,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:09:06Z </begin><end>2008-08-18T22:10:30Z</end></TimeSpan>

<name>B14</name>
<Icon><href>b_175.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:09:06PM (PST)
]]></description>
<Point><coordinates>-120.703050, 35.751117,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:09:06Z </begin><end>2008-08-18T22:10:30Z</end></TimeSpan>

<name>C14</name>
<Icon><href>c_025.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:09:06 PM (PST)
]]></description>
<Point><coordinates>-120.919071, 35.732546,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:09:06Z </begin><end>2008-08-18T22:10:30Z</end></TimeSpan>

<name>D14</name>
<Icon><href>d_270.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:09:06 PM (PST)
]]></description>
<Point><coordinates>-120.873208, 35.672598,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:09:06Z </begin><end>2008-08-18T22:10:30Z</end></TimeSpan>

<!-- ********** 15th POSITION ALL UAVs********** -->
<name>A15</name>
<Icon><href>a_140.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:09:48PM (PST)
]]></description>
<Point><coordinates>-120.762411, 35.824742,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:09:48Z </begin><end>2008-08-18T22:11:12Z</end></TimeSpan>

<name>B15</name>
<Icon><href>b_175.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:09:48 PM (PST)
]]></description>
<Point><coordinates>-120.702094, 35.742070,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:09:48Z </begin><end>2008-08-18T22:11:12Z</end></TimeSpan>

<name>C15</name>
<Icon><href>c_025.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:09:48PM (PST)
]]></description>
<Point><coordinates>-120.914681, 35.740809,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:09:48Z </begin><end>2008-08-18T22:11:12Z</end></TimeSpan>

<name>D15</name>
<Icon><href>d_270.png</href></Icon>

<description><![CDATA[
as of 18/8/2008 14:09:48 PM (PST)
]]></description>
<Point><coordinates>-120.884406, 35.672876,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:09:48Z </begin><end>2008-08-18T22:11:12Z</end></TimeSpan>

<!-- ********** 16th POSITION ALL UAVs********** -->
<name>A16</name>
<Icon><href>a_140.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:10:30PM (PST)
]]></description>
<Point><coordinates>-120.755294, 35.817712,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:10:30Z </begin><end>2008-08-18T22:11:54Z</end></TimeSpan>

<name>B16</name>
con><href>b_175.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:10:30PM (PST)
]]></description>
<Point><coordinates>-120.701092, 35.733069,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:10:30Z </begin><end>2008-08-18T22:11:54Z</end></TimeSpan>

<name>C16</name>
<Icon><href>c_025.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:10:30 PM (PST)
]]></description>
<Point><coordinates>-120.910420, 35.749028,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:10:30Z </begin><end>2008-08-18T22:11:54Z</end></TimeSpan>

<name>D16</name>
<Icon><href>d_270.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:10:30PM (PST)
]]></description>
<Point><coordinates>-120.895341, 35.673045,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:10:30Z </begin><end>2008-08-18T22:11:54Z</end></TimeSpan>

<!-- ********** 17th POSITION ALL UAVs********** -->
<name>A17</name>
<Icon><href>a_140.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:11:12PM (PST)
]]></description>
<Point><coordinates>-120.748049, 35.810837,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:11:12Z </begin><end>2008-08-18T22:12:36Z</end></TimeSpan>

<name>B17</name>
<Icon><href>b_175.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:11:12PM (PST)
]]></description>
<Point><coordinates>-120.700051, 35.724070,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:11:12Z </begin><end>2008-08-18T22:12:36Z</end></TimeSpan>

<name>C17</name>
<Icon><href>c_025.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:11:12PM (PST)
]]></description>
<Point><coordinates>-120.906222, 35.757468,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:11:12Z </begin><end>2008-08-18T22:12:36Z</end></TimeSpan>

<name>D17</name>
<Icon><href>d_330.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:11:12PM (PST)
]]></description>
<Point><coordinates>-120.906284, 35.673131,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:11:12Z </begin><end>2008-08-18T22:12:36Z</end></TimeSpan>
<!-- ********** 18th POSITION ALL UAVs********** -->
<name>A18</name>

<Icon><href>a_140.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:11:54PM (PST)
]]></description>
<Point><coordinates>-120.740965, 35.803967,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:11:54Z </begin><end>2008-08-18T22:13:18Z</end></TimeSpan>

<name>B18</name>
<Icon><href>b_230.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:11:54PM (PST)
]]></description>
<Point><coordinates>-120.699189, 35.714649,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:11:54Z </begin><end>2008-08-18T22:13:18Z</end></TimeSpan>

<name>C18</name>
<Icon><href>c_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:11:54PM (PST)
]]></description>
<Point><coordinates>-120.901772, 35.765756,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:11:54Z </begin><end>2008-08-18T22:13:18Z</end></TimeSpan>

<name>D18</name>
<Icon><href>d_330.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:11:54PM (PST)
]]></description>
<Point><coordinates>-120.910394,35.681458,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:11:54Z </begin><end>2008-08-18T22:13:18Z</end></TimeSpan>

<!-- ************************** 19th POSITION ALL UAVs************************** -->
<name>A19</name>
<Icon><href>a_140.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:12:36PM (PST)
]]></description>
<Point><coordinates>-120.733747, 35.797099,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:12:36Z </begin><end>2008-08-18T22:14:00Z</end></TimeSpan>

<name>B19</name>
<Icon><href>b_230.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:12:36PM (PST)
]]></description>
<Point><coordinates>-120.708393, 35.709786,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:12:36Z </begin><end>2008-08-18T22:14:00Z</end></TimeSpan>

<name>C19</name>
<Icon><href>c_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:12:36PM (PST)
]]></description>
<Point><coordinates>-120.890737, 35.767305,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:12:36Z </begin><end>2008-08-18T22:14:00Z</end></TimeSpan>

<name>D19</name>
<Icon><href>d_330.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:12:36PM (PST)
]]></description>
<Point><coordinates>-120.914796,35.689834,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:12:36Z </begin><end>2008-08-18T22:14:00Z</end></TimeSpan>

<!-- ************************ 20th POSITION ALL UAVs************************ -->
<name>A20</name>
<Icon><href>a_140.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:13:18PM (PST)
]]></description>
<Point><coordinates>-120.726657, 35.790237,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:13:18Z </begin><end>2008-08-18T22:14:42Z</end></TimeSpan>

<name>B20</name>
<Icon><href>b_230.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:13:18PM (PST)
]]></description>
<Point><coordinates>-120.717831, 35.705067,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:13:18Z </begin><end>2008-08-18T22:14:42Z</end></TimeSpan>

<name>C20</name>
<Icon><href>c_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:13:18PM (PST)
]]></description>
<Point><coordinates>-120.879525, 35.768435,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:13:18Z </begin><end>2008-08-18T22:14:42Z</end></TimeSpan>

<name>D20</name>
con><href>d_330.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:13:18PM (PST)
]]></description>
<Point><coordinates>-120.919306,35.698005,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:13:18Z </begin><end>2008-08-18T22:14:42Z</end></TimeSpan>

<!-- ********** 21st POSITION ALL UAVs********** -->
<name>A21</name>
<Icon><href>a_140.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:14:00PM (PST)
]]></description>
<Point><coordinates>-120.719493, 35.783375,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:14:00Z </begin><end>2008-08-18T22:15:24Z</end></TimeSpan>

<name>B21</name>
<Icon><href>b_230.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:14:00PM (PST)
]]></description>
<Point><coordinates>-120.727257, 35.700287,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:14:00Z </begin><end>2008-08-18T22:15:24Z</end></TimeSpan>

<name>C21</name>
<Icon><href>c_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:14:00PM (PST)
]]></description>
<Point><coordinates>-120.868753, 35.769639,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:14:00Z </begin><end>2008-08-18T22:15:24Z</end></TimeSpan>

<name>D21</name>
<Icon><href>d_330.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:14:00PM (PST)
]]></description>
<Point><coordinates>-120.923613,35.706350,300</coordinates></Point>
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<!-- ********** 22nd POSITION ALL UAVs********** -->
<name>A22</name>
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as of 18/8/2008 14:14:42PM (PST)
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<name>B22</name>
<Icon><href>b_230.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:14:42PM (PST)
]]></description>
<Point><coordinates>-120.736617, 35.695523,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:14:42Z </begin><end>2008-08-18T22:16:06Z</end></TimeSpan>

<name>C22</name>
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as of 18/8/2008 14:14:42PM (PST)
]]></description>
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<name>D22</name>
<Icon><href>d_090.png</href></Icon>
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as of 18/8/2008 14:14:42PM (PST)
]]></description>
<Point><coordinates>-120.927970, 35.714552,300</coordinates></Point>
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!-- ********** 23rd POSITION ALL UAVs********** -->
<name>A23</name>
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<description><![CDATA[
as of 18/8/2008 14:15:24PM (PST)
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<name>B23</name>
<Icon><href>b_230.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:15:24PM (PST)
]]></description>
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<Icon><href>c_090.png</href></Icon>
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as of 18/8/2008 14:15:24PM (PST)
]]></description>
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<name>D23</name>
<Icon><href>d_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:15:24PM (PST)
]]></description>
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<!-- ********** 24th POSITION ALL UAVs********** -->
<name>A24</name>
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as of 18/8/2008 14:16:06PM (PST)
]]></description>
<Point><coordinates>-120.714610, 35.764691,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:16:06Z </begin><end>2008-08-18T22:17:30Z</end></TimeSpan>

<name>B24</name>
<Icon><href>b_230.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:16:06PM (PST)
]]></description>
<Point><coordinates>-120.755444, 35.686009,300</coordinates></Point>
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<name>C24</name>
<Icon><href>c_090.png</href></Icon>
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as of 18/8/2008 14:16:06PM (PST)
]]></description>
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<TimeSpan><begin>2008-08-18T22:16:06Z </begin><end>2008-08-18T22:17:30Z</end></TimeSpan>

<name>D24</name>
<Icon><href>d_090.png</href></Icon>
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as of 18/8/2008 14:16:06PM (PST)
]]></description>
<Point><coordinates>-120.905779, 35.714208,300</coordinates></Point>
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<!--********** 25th POSITION ALL UAVs********** -->
<name>A25</name>
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<description><![CDATA[
as of 18/8/2008 14:16:48PM (PST)
]]></description>
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<TimeSpan><begin>2008-08-18T22:16:48Z </begin><end>2008-08-18T22:18:12Z</end></TimeSpan>

<name>B25</name>
<Icon><href>b_230.png</href></Icon>
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as of 18/8/2008 14:16:48PM (PST)
]]></description>
<Point><coordinates>-120.764711, 35.681233,300</coordinates></Point>
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<name>C25</name>
<Icon><href>c_090.png</href></Icon>
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as of 18/8/2008 14:16:48PM (PST)
]]></description>
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<name>D25</name>
<Icon><href>d_090.png</href></Icon>
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as of 18/8/2008 14:16:48PM (PST)
]]></description>
<Point><coordinates>-120.894786, 35.714040,300</coordinates></Point>
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<!--********** 26th POSITION ALL UAVs********** -->
<name>A26</name>
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as of 18/8/2008 14:17:30PM (PST)
]]>
</description>
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<TimeSpan><begin>2008-08-18T22:17:30Z </begin><end>2008-08-18T22:18:54Z</end></TimeSpan>

<name>B26</name>
<Icon><href>b_230.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:17:30PM (PST)
]]>
scription>
t><coordinates>-120.774171, 35.676484,300</coordinates></Point><TimeSpan><begin>2008-08-
8T22:17:30Z </begin><end>2008-08-18T22:18:54Z</end></TimeSpan>

<name>C26</name>
<Icon><href>c_180.png</href></Icon>
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as of 18/8/2008 14:17:30PM (PST)
]]></description>
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<name>D26</name>

<Icon><href>d_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:17:30PM (PST)
]]></description>
<Point><coordinates>-120.883778, 35.713804,300</coordinates></Point>
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<!-- ********** 27th POSITION ALL UAVs********************************** -->
<name>A27</name>
<Icon><href>a_230.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:18:12PM (PST)
]]></description>
<Point><coordinates>-120.741853, 35.749362,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:18:12Z </begin><end>2008-08-18T22:19:36Z</end></TimeSpan>

<name>B27</name>
<Icon><href>b_340.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:18:12PM (PST)
]]></description>
<Point><coordinates>-120.784152, 35.671431,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:18:12Z </begin><end>2008-08-18T22:19:364Z</end></TimeSpan>

<name>C27</name>
<Icon><href>c_180.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:18:12PM (PST)
]]></description>
<Point><coordinates>-120.812365, 35.766728,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:18:12Z </begin><end>2008-08-18T22:19:36Z</end></TimeSpan>

<name>D27</name>
<Icon><href>d_090.png</href></Icon>
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as of 18/8/2008 14:18:12PM (PST)
]]></description>
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<TimeSpan><begin>2008-08-18T22:18:12Z </begin><end>2008-08-18T22:19:36Z</end></TimeSpan>

<!-- ********** 28th POSITION ALL UAVs********************************** -->
<name>A28</name>
<Icon><href>a_230.png</href></Icon>
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as of 18/8/2008 14:18:54PM (PST)
]]></description>
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<name>B28</name>
<Icon><href>b_340.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:18:54PM (PST)
]]></description>
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<name>C28</name>
<Icon><href>c_180.png</href></Icon>
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as of 18/8/2008 14:18:54PM (PST)
]]></description>
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<name>D28</name>
<Icon><href>d_090.png</href></Icon>
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as of 18/8/2008 14:18:54PM (PST)
]]></description>
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<TimeSpan><begin>2008-08-18T22:18:54Z </begin><end>2008-08-18T22:20:18Z</end></TimeSpan>

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<!-- ********** 29th POSITION ALL UAVs********************************** -->
<name>A29</name>
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<TimeSpan><begin>2008-08-18T22:19:36Z </begin><end>2008-08-18T22:21:00Z</end></TimeSpan>

<name>B29</name>
<Icon><href>b_340.png</href></Icon>
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<name>D29</name>
<Icon><href>d_090.png</href></Icon>
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<!-- ********** 30th POSITION ALL UAVs********************************** -->
<name>A30</name>
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<description><![CDATA[<br>as of 18/8/2008 14:20:18PM (PST)<br>]]></description>
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<name>B30</name>
<Icon><href>b_340.png</href></Icon>
<description><![CDATA[<br>as of 18/8/2008 14:20:18PM (PST)<br>]]></description>
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<name>C30</name>
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<name>D30</name>
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<!--********** 31st POSITION ALL UAVs********************************** -->
<name>A31</name>
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<TimeSpan><begin>2008-08-18T22:21:00Z </begin><end>2008-08-18T22:21:42Z</end></TimeSpan>

<name>B31</name>
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as of 18/8/2008 14:21:00PM (PST)
]]></description>
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<name>C31</name>
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as of 18/8/2008 14:21:00PM (PST)
]]></description>
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con><href>d_090.png</href></Icon>
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as of 18/8/2008 14:21:00PM (PST)
]]></description>
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<!-- ********** 32nd POSITION ALL UAVs********** -->
<name>A32</name>
<Icon><href>a_230.png</href></Icon>
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as of 18/8/2008 14:21:42PM (PST)
]]></description>
<Point><coordinates>-120.796350, 35.718400,300</coordinates></Point>
<TimeSpan><begin>2008-08-18T22:21:42Z </begin><end>2008-08-18T22:22:24Z</end></TimeSpan>

<name>B32</name>
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as of 18/8/2008 14:21:42PM (PST)
]]></description>
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<name>C32</name>
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as of 18/8/2008 14:21:42PM (PST)
]]></description>
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<TimeSpan><begin>2008-08-18T22:21:42Z </begin><end>2008-08-18T22:22:24Z</end></TimeSpan>

<name>D32</name>
<Icon><href>d_090.png</href></Icon>
<description><![CDATA[
as of 18/8/2008 14:21:42PM (PST)
]]></description>
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<TimeSpan><begin>2008-08-18T22:21:42Z </begin><end>2008-08-18T22:22:24Z</end></TimeSpan>

APPENDIX C. ICON MODIFICATION PROCEDURE

1) Start GIMP

2) File> Open>filename.gif

3) Select the magic wand tool and select the icon's contiguous regions to modify. Ctrl click to deselect a region, Shift-click to add another region to the selection.

4) Select the bucket tool, and left click on the foreground colour pallet. The colour pallet selection window will appear. Select the desired colour and click OK. The colour palette selection window will close.

5) Left click in the area of the icon that was previously selected with the magic wand tool.

6) The icon will now appear in the selected colour.

There are two ways to rotate the image. The way described is more versatile, since it allows the user to free rotate the icon to any direction and any angle of rotation. The second, simpler method is useful if 90 and 180 degree rotations are all that is required.

7) Select (left click) the rotate tool from the palette.

8) Left click on the icon (or image to be rotated) The rotate menu will appear.

9) If the dot for the center of rotation is not in the center of the icon, it can be moved with the center x and y up and down arrows. Once it is centered, enter the number of degrees for rotation, or use the sliding button below the angle field.

10) Copy the image, using the drop down menus or by using the Ctrl C keyboard command

11) Select Edit>Paste as New. A new unnamed image window will appear with the icon in the center

12) Select Layer> Transparency> Color to Alpha. The Color to alpha window will appear. Accept the defaults and click OK

13) select File> Save As and enter the new name to be saved and the directory where the file should be saved. Click on the Select file type (by Extension) + button and scroll down to the .png extension.

The newly coloured, rotated and transparent background icon is ready for use in the KML file that will drive the simulation. Examples of all four icons appear below:

APPENDIX D. INFORMED CONSENT FORM - NPS

Naval Postgraduate School
Informed Consent Form

Introduction. You are invited to participate in a study entitled Situational Awareness aids in the control of Multiple Uninhabited Air Vehicles.

Procedures. This study will investigate what effects a Situational Awareness display will have upon a participant's ability to provide supervisory control of multiple Uninhabited Air Vehicles (UAVs). You will provide supervisory control of up to 4 simulated UAVs with and without the use of a composite display showing an overhead view (plan view) of the UAVs flying in the simulated Camp Roberts training area. You will monitor the progress of the UAV along their pre-planned missions using an individual display for each vehicle that represents an onboard camera. You will be interrupted at several points during the experiment to assess their awareness of the locations of the various UAVs as well as targets of interest on the ground.

My participation in the experiment will last approximately 45 minutes. The experiment will consist of verbal instructions, a training session, and a final criterion trial. I understand that during the trial, I will be asked specific questions by the experimenter in regards to the locations of the UAVs and targets in the scenario.

Risks and Benefits. I understand that this project does not involve greater than minimal risk and involves no known reasonably foreseeable risks or hazards greater than those encountered in everyday life. I have also been informed of any benefits to myself or to others that may reasonably be expected as a result of this research.

Compensation. I understand that no tangible compensation will be given. I understand that a copy of the research results will be available at the conclusion of the experiment by contacting the PI, Dr. Michael McCauley (memccaul@nps.edu, 831-656-2191) or the experimenter, Maj Derek Sebalj (dsebalj@nps.edu, 831-601-2853).

Confidentiality & Privacy Act. I understand that all records of this study will be kept confidential and that my privacy will be safeguarded. No information will be publicly accessible which could identify me as a participant. I will be identified only as a code number on all research forms/data bases. My name on any signed document will not be paired with my code number in order to protect my identity. I understand that records of my participation will be maintained by NPS for three years, after which they will be destroyed.

Voluntary Nature of the Study. I understand that my participation is strictly voluntary, and if I agree to participate, I am free to withdraw at any time without prejudice.

Points of Contact. I understand that if I have any questions or comments regarding this project upon the completion of my participation, I should contact the Principal Investigator, Dr. Michael McCauley , 831-656-2191 memccaul@nps.edu. Any medical questions should be addressed to Col George Patrin, MD, USA, (CO, POM Medical Clinic), (831) 242-7550, george.patrin@us.army.mil. Any other questions or concerns may be addressed to the IRB Chair, LT Paul O'Connor, 656-3864, peoconn0@nps.edu.

Statement of Consent. I have been provided with a full explanation of the purpose, procedures, and duration of my participation in this research project. I understand how my identification will be safeguarded and have had all my questions answered. I have been provided a copy of this form for my records and I agree to participate in this study. I understand that by agreeing to participate in this research and signing this form, I do not waive any of my legal rights.

_____ _____

Participant's Signature Date

_____ _____

Researcher's Signature Date

APPENDIX E. PRETEST QUESTIONNAIRE

Pretest Questionnaire

Participant Number:_____

1. Age:_____
2. Gender: Male Female
3. Military Rank:_____
4. Years of Military Service:_____
5. How many hours of sleep did you get last night (nearest ½ hour)?
   _____

   a. How many hours of sleep do you average per night? _____
6. Are you a pilot or non-flying officer (Navigator, WSO, Observer, Crewman, Systems operator) who conduct their job in an aircraft?
   Yes No

   a. If Yes, Flying Hours (all types):___
7. Are you a private pilot? Yes No

   a. If Yes, Flying hours (approximately)_____
8. Do you regularly play computer based flight simulator games or fly Radio Controlled aircraft? Yes No

   a. Hours played/controlled per week?
   _____

Do you have battle tracking experience? Yes No

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APPENDIX F. PARTICIPANT INSTRUCTIONS

You are a UAV pilot, in command of four UAVs. There are four (5) displays directly in front of you. Each display is a simulation of an augmented reality scene where icon and other computer generated graphics are overlaid on the scene. For this reason, items appear on the screen that are not in the actual scene to help you determine your geographic position, such as the names of landmarks, street and road names, the Latitude and Longitude of a position on the ground, etc.

The view represents a simulated view from the camera onboard the UAV. The camera will pan to give the best view, and zoom into the various waypoints, sometimes giving the impression that the UAV is flying backwards – do not be alarmed, the UAV is moving forward, but the zoom is giving you the impression otherwise. The UAV will move from waypoint to waypoint on its own, according to a pre-determined flight plan. You are providing supervisory control of the aircraft. This means that the aircraft will proceed with its pre-loaded flight plan unless you, the pilot decide that it should go elsewhere. For the purposes of this simulation and experiment, you control the aircraft by giving verbal instructions to the experimenter. No manual control of the UAV is required. Your inputs to control the aircraft will come in response to questions from the experimenter. If the experimenter does not ask any questions, continue to monitor the progress of the UAVs and note the position of the ground targets. When asked a question by the experimenter, please answer as quickly and accurately as possible. All questions will deal with the location of ground targets and which aircraft you would task to investigate a particular ground target.

(point to the appropriate area of the display):

Lower left hand corner – decimal latitude and longitude of the center of the display. Above this is a scale of distances on the display – the scale will change according to UAV altitude, i.e., at a higher altitude, the same scale represents a longer distance, and at lower altitudes, the scale represents a longer distance. This distance is shown at the top of the scale.

- Ground elevation in the bottom center of the display
- Eye altitude (sensor) on the lower right hand side of display
- North Pointer – N – at the top right hand side of the display

Zoom and Pan tools are also located at the top right hand side of the display, but neither will be used during the experiment. On the left hand side of the display, you will see the waypoints that the UAV will navigate during the scenario. The highlighted waypoint represents the next point where the UAV is headed. When that waypoint is reached, the next waypoints will be highlighted.

All four UAVs will launch and proceed to their assigned areas. Your task is to monitor all of the UAVs and note the positions of the blue and red rectangles on the ground. The scenario start time is 10:00 UTC (14:00 PDT) on 18 August 2008. At the start of the scenario, all the UAVs have arrived at their first waypoints and are proceeding to the second waypoint. Do you have any questions?

Instructions for the SA Augmented Scenario (Read prior to SA augmented scenario)

On the fifth display, you will see a plan view of all four UAV operating areas. The operating area for UAV A is displayed in yellow, UAV B in green, UAV C in blue, and UAV D in purple. The display will update as each UAV reaches the next waypoint. The waypoints are set at approximately every 1 kilometer. The UAVs will fly directly from one waypoint to the next, in numerical sequence. You can refer to this display at any time during the scenario, however, you are still responsible for monitoring each of the UAVs cameras for ground targets. Do you have any questions?

APPENDIX G. SCENARIO 1 QUESTIONS

Scenario 1 Questions: **Run: 1 / 2** **SA on / off**

1. Between Waypoint 8 and 9 ask:

You must reinvestigate the Blue target between found between Waypoint C2 and C3. Which closest UAV should you dispatch?

Answer	____	D-C-B-A
Confidence	____	
Turn	____	R

2. Between Waypoint 16 and 17 ask:

You must reinvestigate the Red target between found between Waypoint D3 and D4. Which closest UAV should you dispatch?

Answer	____	B-D-C-A
Confidence	____	
Turn	____	R

3. Between Waypoint 17 and 18 ask:

You must reinvestigate the Red target between found between Waypoint B3 and B4. Which closest UAV should you dispatch?

Answer	____	B-A-C-D
Confidence	____	
Turn	____	R

4. Between Waypoint 18 and 19 ask:

You must reinvestigate the Blue target between found between Waypoint A7 and A8. Which closest UAV should you dispatch?

Answer	____	C-A-B-D
Confidence	____	
Turn	____	R

5. Between Waypoint 29 and 30 ask:

You must reinvestigate the Blue target between found between Waypoint C2 and C3. Which closest UAV should you dispatch?

Answer	____	D-B-C-A
Confidence	____	
Turn	____	R or D-straight

6. Between Waypoint 30 and 31 ask:

You must reinvestigate the Red target between found between Waypoint B25 and B26. Which closest UAV should you dispatch?

Answer	____	B-A-C-D
Confidence	____	
Turn	____	B-D turn L, A-C turn R

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APPENDIX H. SCENARIO 2 QUESTIONS

Scenario 2 Questions: **Run: 1 / 2** **SA on / off**

1. Between Waypoint 13 and 14 ask:

You must reinvestigate the Blue target between found between Waypoint C6 and C7 Which closest UAV should you dispatch?

Answer	____	C-A-B-D
Confidence	____	
Turn	____	L all

2. Between Waypoint 14 and 15 ask:

You must reinvestigate the Red target between found between Waypoint B2 and B3. Which closest UAV should you dispatch?

Answer	____	B-D-C-A
Confidence	____	
Turn	____	L all

3. Between Waypoint 19 and 20 ask:

You must reinvestigate the Red target between found between Waypoint A2 and A3. Which closest UAV should you dispatch?

Answer	____	B-D-A-C
Confidence	____	
Turn	____	L all

4. Between Waypoint 21 and 22 ask:

You must reinvestigate the Blue target between found between Waypoint D6 and D7. Which closest UAV should you dispatch?

Answer	____	C-D-A-B
Confidence	____	
Turn	____	R or D-straight

5. Between Waypoint 24 and 25 ask:

You must reinvestigate the Red target between found between Waypoint A14 and A15. Which closest UAV should you dispatch?.

Answer	____	B-A-D-C
Confidence	____	
Turn	____	L all, B-Right

6. Between Waypoint 30 and 31 ask:

You must reinvestigate the Red target between found between Waypoint A23 and A24. Which closest UAV should you dispatch?

Answer	____	A-B-C-D
Confidence	____	
Turn	____	B-D turn R, A-C turn L

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